PB84-229657

Evaluation of Natural- and Forced-Draft Staging Air Systems for Nitric Oxide Reduction in Refinery Process Heaters
Volume 2. Data Supplement

KVB, Inc., Irvine, CA

Prepared for

Industrial Environmental Research Lab.
Research Triangle Park, NC

Aug 84

U.S. Department of Commerce
National Technical Information Service
NTIS

PB84-229657

EPA-600/7-84-080b
August 1984

EVALUATION OF NATURAL- AND FORCED-DRAFT STAGING AIR SYSTEMS FOR NITRIC OXIDE REDUCTION IN REFINERY PROCESS HEATERS

Volume II. Data Supplement

by

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NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA-600/7-84-080b	2.	3. RECIPIENT'S ACCESSION NO. PB85 229657
4. TITLE AND SUBTITLE Evaluation of Natural- and Forced-Draft Staging Air Systems for Nitric Oxide Reduction in Refinery Process Heaters; Volume II. Data Supplement		5. REPORT DATE August 1984 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) R. C. Benson, R. A. Frohoff, and J. A. Markee		8. PERFORMING ORGANIZATION REPORT NO. KVB72-806032-1926 D147
9. PERFORMING ORGANIZATION NAME AND ADDRESS KVB, Inc. 18006 Skypark Boulevard Irvine, California 92714		10. PROGRAM ELEMENT NO. 11. CONTRACT/GRANT NO. 68-02-3690
12. SPONSORING AGENCY NAME AND ADDRESS EPA, Office of Research and Development Industrial Environmental Research Laboratory Research Triangle Park, NC 27711		13. TYPE OF REPORT AND PERIOD COVERED Final; 10/82 - 2/84 14. SPONSORING AGENCY CODE EPA/600/13

15. SUPPLEMENTARY NOTES IERL-RTP project officer is Robert E. Hall, Mail Drop 65, 919/541-2477.

16. ABSTRACT The two-volume report gives results of pilot-scale tests to evaluate combustion modifications for emission reduction and efficiency enhancement on petroleum process heaters. Objectives were to determine nitric oxide (NO) emission reductions, thermal efficiency changes, long-term performance, and cost of both natural- and forced-draft staged-combustion-air modifications. Forced-draft staged-combustion-air modifications had been shown to be the most promising combustion modification in previous pilot-scale tests. The test unit was a vertical, cylindrical, natural-draft crude heater, and the test fuels were natural gas, refinery gas, and a combination of No. 6 oil and refinery gas. The unit had a 16 MW heat input capacity and was capable of a maximum throughput of 108 cu m/h of crude oil (rated input 96 cu m/h). The natural-draft system (staging with lowered excess air) has a cost of $0.03/lb NO on a 29.3 MW natural-draft process heater, compared to $0.32/lb NO for a forced-draft system. A natural-draft staging air system, capable of providing 50% of the staging air for 100% refinery gas firing and crude charge rates of 55-90% rated capacity, reduced NO emissions by about 50%. The stack O2 was lowered from 4% baseline to 2% low NO condition. The efficiency gain with the natural-draft staging air system was about 1.5%, and with forced-draft, 5%.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Pollution	Pollution Control	13B
Nitric Oxide	Stationary Sources	07B
Refineries	Combustion Modification	13I
Heating Equipment	Staging Air	13A
Combustion Control		21B

18. DISTRIBUTION STATEMENT Release to Public	19. SECURITY CLASS *(This Report)* Unclassified	21. NO. OF PAGES 193
	20. SECURITY CLASS *(This page)* Unclassified	22. PRICE

EPA Form 2220-1 (9-73)

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This document has been reviewed in accordance with U.S. Environmental Protection Agency policy and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

LIMITATIONS ON APPLICATION OF DATA REPORTED

The pollutant emission data cited in this report pertain to one specific classification of refinery process heaters, i.e., vertical cylindrical natural draft crude heaters. These data should not be used to estimate mean emissions from other types of heaters or to predict emission reduction potentials of combustion modifications until modifications have actually been carried out on the different heater types. The purpose of this test program was to investigate the feasibility of combustion modifications for emissions control, not to develop a comprehensive emissions data base.

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FOREWORD

The purpose of this Data Supplement is to document data in greater detail than was practical in the final report for this contract. It is intended to provide the necessary details to other researchers who are interested in performing their own analysis.

Readers are referred to the contract final report for information as to objectives, selection of units, measurement procedures, interpretations, and conclusions.*

All data presented for gaseous emission concentrations of NO, CO, SO_2, and SO_3 are expressed in parts per million by volume (ppm) on a dry basis corrected to 3 percent O_2 by volume (dry) in the flue gas.

The data are arranged in this volume by Location Number for Site 2. At this location two distinct data sets were collected. The first set (October 5 - October 27, 1982) was with gas firing only. The second set of data (February 8 - June 10, 1983) was with a nominal ratio of 80% oil/20% gas. The contract final reports refer to the test number when data are discussed. The test number is of the form xx/yy-zz, where xx = month, yy = day, and zz = test number.

For the unit tested, the data supplement contains the following information:

1. Equipment Design Data

   Design data tabulations include: unit description, installation date, process capacity, burner description, fuels burned, combustion air temperature and other data pertinent to each unit.

2. Mobile Laboratory Data (Emission Measurements)

   Emission measurements tabulated for each test include test number, test load, combustion conditions (O_2, CO_2), gaseous emissions (NO, CO, and SO_2 all at 3 percent O_2, dry), total particulates and solid (filterable) particulates, thermal efficiency, Bacharach smoke spot number, and plume opacity.

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* EPA-600/7-84-080a, August 1984.

3. Operating Data

Data pertinent to the process are tabulated for each test.

4. Fuel Analyses

Analyses of test fuels are included as reported for fuel samples collected during tests.

5. Particulates Measurement Data

Particulates data include measurements of total and solid particulates by EPA Method 5.

6. Cascade Impactor Data

Impactor data include impactor flow conditions, stage collection weights, and calculated aerodynamic particle size for each stage.

The impactor used was an Anderson 2000 Mark III with the following stage dimensions:

Stage No.	Jet Diameter, cm
1	0.1638
2	0.1253
3	0.0948
4	0.0759
5	0.0567
6	0.0359
7	0.0261
8	0.0251

7. Opacity Data

Plume opacity was observed by EPA Method 9.

8. Stack Traverse Data

Stack traverses are made with a pitot tube.

Dash marks entered on the data forms indicate that data were not available.

INSTRUMENTATION

All gaseous emission measurements were made in a 12.8 m x 2.4 m (8 x 42 ft) mobile laboratory trailer. The particulate concentration, particulate size, and sulfur oxides measurements were made by instrumentation prepared in the wet chemistry area of the laboratory and taken to the sample port. Weighing and titrations were done at KVB's stationary laboratory facility.

The emission measurement instrumentation used was the following:

EMISSION MEASUREMENT INSTRUMENTATION

Species	Manufacturer	Measurement Method	Model No.
Carbon Monoxide	Beckman Instruments	IR Spectrometer	865
Oxygen	Teledyne	Polarographic	326A
Carbon Dioxide	Beckman Instruments	IR Spectrometer	864
Nitrogen Oxides	Thermo Electron Co.	Chemiluminescent	10A
Particulates	Andersen Samplers, Inc.	EPA Method 5 Train	EPA
Sulfur Dioxide	DuPont Instruments	UV Spectrometer	400
Particle Sizing	Andersen Samplers, Inc.	Cascade Impactor	Mark III
Smoke Spot	Bacharach	ASTM 2156-65	RCC
Opacity		EPA Method 9	
Sulfur Oxides (SO_x)		Goksoyr-Ross	

CONVERSION FACTORS
SI Units to Metric or English Units

To Obtain	From	Multiply By	To obtain ppm at 3% O_2 of	Multiply* Concentration in ng/J by
g/Mcal	ng/J	0.004186	Natural Gas Fuel	
10^6 Btu	GJ	0.948	CO	3.23
Btu	gm cal	3.9685×10^{-3}	HC	5.65
lb/10^6 Btu	ng/J	0.00233	NO or NO_x	1.96
ft	m	3.281	SO_2 or SO_x	1.41
in.	cm	0.3937		
ft^2	m^2	10.764		
ft^3	m^3	35.314	Oil Fuel	
lb	kg	2.205	CO	2.93
Fahrenheit	Celsius	$t_F = 9/5(t_C) + 32$	HC	5.13
Fahrenheit	Kelvin	$t_F = 1.8t_K - 460$	NO or NO_x	1.78
psig	Pa	$P_{psig} = (P_{pa})(1.450 \times 10^{-4}) - 14.7$	SO_2 or SO_x	1.28
psia	Pa	$P_{psia} = (P_{pa})(1.450 \times 10^{-4})$		
iwg (39.2°F)	Pa	$P_{iwg} = (P_{pa})(4.014 \times 10^{-3})$	Coal Fuel	
10^6 Btu/hr	MW	3.413	CO	2.69
GJ/hr	MW	3.60	HC	4.69
			NO or NO_x	1.64
			SO_2 or SO_x	1.18

*These conversions depend on fuel composition. The values given are for typical fuels.

CONVERSION FACTORS
English or Metric Units to SI Units

To Obtain	From	Multiply By	To obtain ng/J of	Multiply* Concentration in ppm @ 3% O_2 by
ng/J	lb/10^6 Btu	430	Natural Gas Fuel	
ng/J	g/Mcal	239	CO	0.310
GJ	10^6 Btu	1.055	HC	0.177
m	ft	0.3048	NO or NO_x (as NO_2)	0.510
cm	in.	2.54	SO_2 or SO_x	0.709
m^2	ft^2	0.0929		
m^3	ft^3	0.02832		
kg	lb	0.4536	Oil Fuel	
Celsius	Fahrenheit	$t_C = 5/9\ (t_F - 32)$	CO	0.341
Kelvin	Fahrenheit	$t_K = 5/9\ (t_F - 32) + 273$	HC	0.195
Pa	psig	$P_{pa} = (P_{psig} + 14.7)(6.895 \times 10^3)$	NO or NO_x (as NO_2)	0.561
Pa	psia	$P_{pa} = (P_{psia})(6.895 \times 10^3)$	SO_2 or SO_x	0.780
Pa	iwg (39.2°F)	$P_{pa} = (P_{iwg})(249.1)$	Coal Fuel	
MW	10^6 Btu/hr	0.293	CO	0.372
MW	GJ/hr	0.278	HC	0.213
			NO or NO_x (as NO_2)	0.611
			SO_2 or SO_x	0.850

*These conversions depend on fuel composition. The values given are for typical fuels.

REFINERY PROCESS HEATER DESCRIPTION

Location No. 2

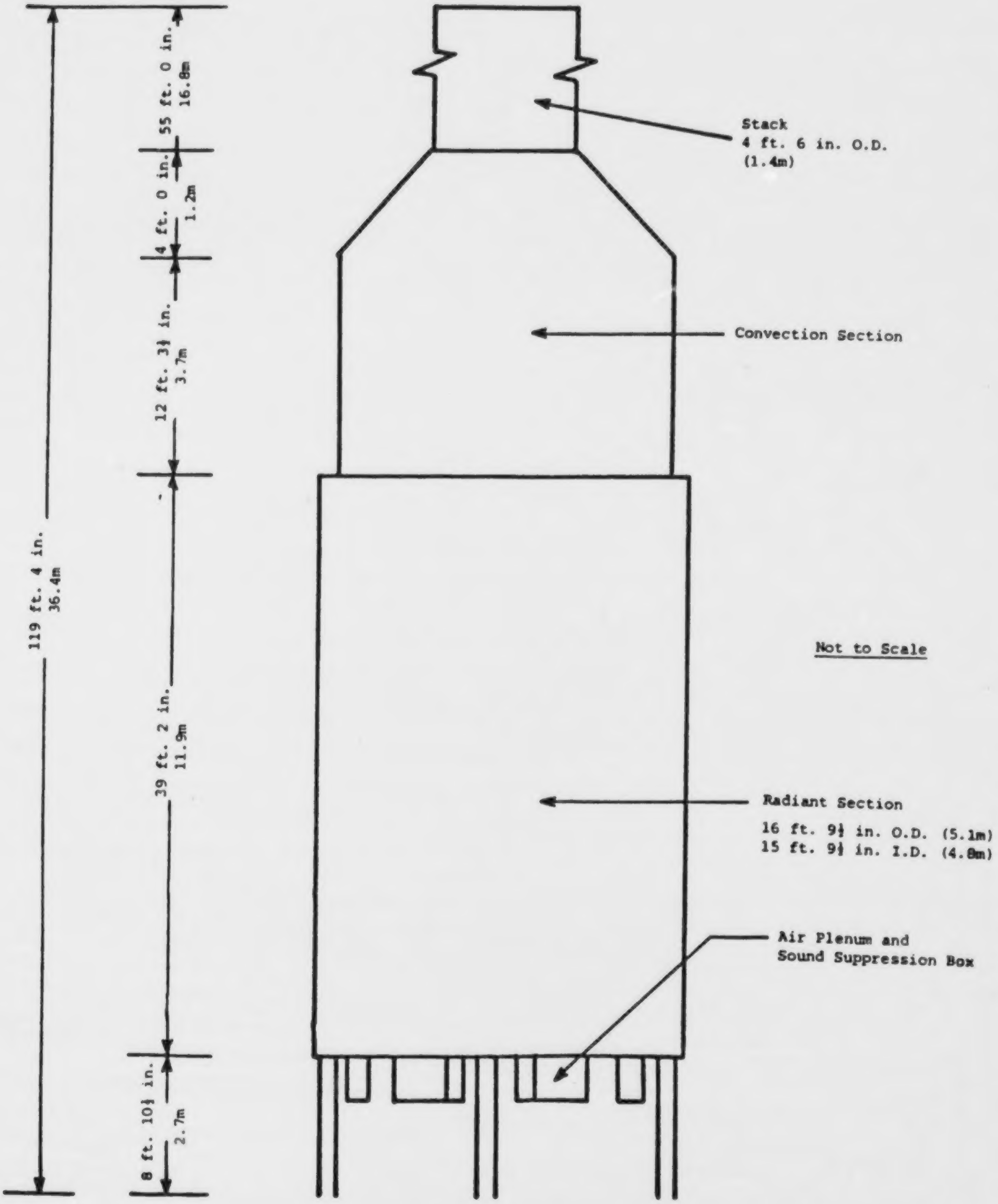
Unit No. 11H13

Unit Description: Crude Oil Heater
Vertical Cylindrical
Natural Draft
#6 Oil/Gas Burners

Installation Date: 1974

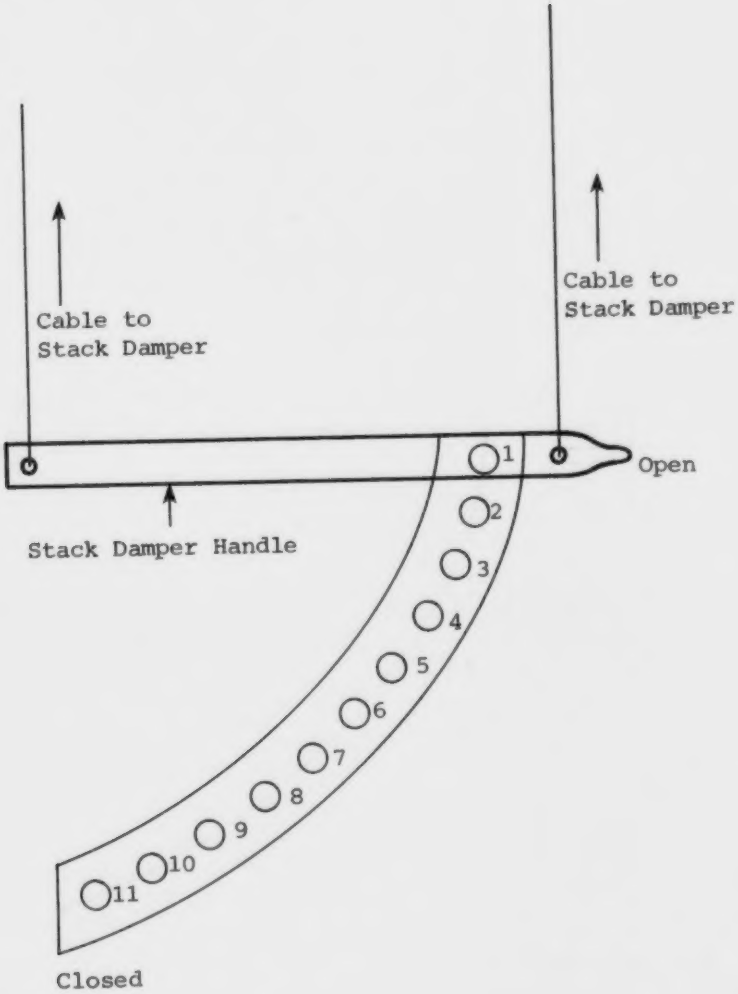
Rated Capacity: 91.8 m^3/h (14,000 bbl/day)

Burner Description: (6) John Zink DBA-22 Natural Draft Burners


55 ft. 0 in.
16.8m
4 ft. 0 in.
1.2m
12 ft. 3½ in.
3.7m
39 ft. 2 in.
11.9m
8 ft. 10½ in.
2.7m
119 ft. 4 in.
36.4m
Stack
4 ft. 6 in. O.D.
(1.4m)
Convection Section
Not to Scale
Radiant Section
16 ft. 9½ in. O.D. (5.1m)
15 ft. 9½ in. I.D. (4.8m)
Air Plenum and
Sound Suppression Box

Sketch of the process heater at Location 2.

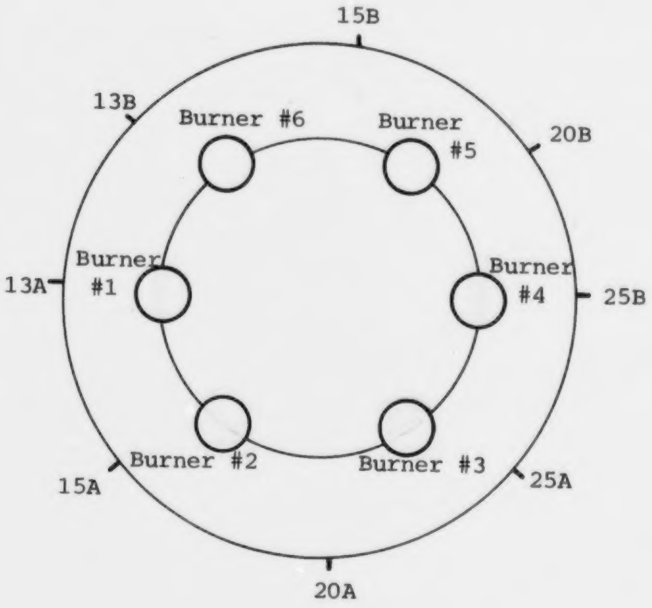
STACK DAMPER ADJUSTMENT


Cable to
Stack Damper
Cable to
Stack Damper
1
Open
2
Stack Damper Handle
3
4
5
6
7
8
9
10
11
Closed

Stack damper is manually controlled at ground level. In operating data sheet reference is made to relative position of the damper from test to test. In the above figure, eleven notches or openings are shown. The notch number is sometimes referenced on the data sheets to give an adjustment indication that the stack damper has been either opened or closed from test to test.

TUBE PASS TEMPERATURE MEASUREMENTS

Approximate locations of tube skin temperature thermocouples are 12 feet above the bottom of the heater.


15B
13B
Burner #6
Burner #5
20B
Burner #1
13A
Burner #4
25B
Burner #2
Burner #3
15A
25A
20A

Tube Pass Thermocouples

13A	13B
15A	15B
20A	20B
25A	25B

Maximum Allowable Tube Skin Measurement = 1225°F

DATA SET 1

OCTOBER 5 - OCTOBER 27, 1982

MOBILE LABORATORY DATA

Test No. 10/5-1

Test No. 10/5-1 Date 10/5/82 Location SITE 2 Engr. BENSON

Unit No. 11 H13 Fuel Adsorber Gas RATED Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

1. Test No.	10/5-1									
2. Date	10/5/82									
3. Time	ALL DAY									
4. Load 10⁶ BTU/Hr	—									
5. Process Rate bbl/day	9423									
6. Flue Diam. or Size, ft	4.2									
7. Probe Position	STACK									
8. Oxygen (%)	6.6									
9. NOx (hot) read/3% O_2 (ppm)*	—	—								
10. NO (hot) read/3% O_2 (ppm)*	—	—								
11. NO_2 (hot) read/3% O_2 (ppm)*	—	—								
12. NO (cold) read/3% O_2 (ppm)*	122	153								
13. Carbon Dioxide (%)	9.4									
14. Carbon Monoxide (ppm) uncor/cor*	3	3								
15. Hydrocarbon (ppm) uncor/cor*	—	—								
16. Sulfur Dioxide (ppm) uncor/cor*	1	1								
17. Smoke Spot (Bacharach)	—									
18. Atmos. Temp. (°F/°C)	—									
19. Dew Point Temp. (°F/°C)	—									
20. Atmos. Pressure (in. Hg)	—									
21. Relative Humidity (%)	—									
22.										
23.										
24.										
25.										
26.										
27.										
28.										
29.										
30.										

*Correction to 3% O_2 should not be performed if the value is measured on a wet basis.

Data Sheet 6002-2

MOBILE LABORATORY DATA Test No. 10/6/82

Test No. 10/6-1 Date 10/6/82 Location SITE 2 Engr. BENSON

Unit No. 11H13 Fuel Adsorber Gas RATED Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

1. Test No.	10/6-1									
2. Date	10/6/82									
3. Time	ALL DAY									
4. Load 10^6 BTU/HR	46.7									
5. Process Rate bbl/day	11400									
6. Flue Diam. or Size, ft	4.2									
7. Probe Position	STACK									
8. Oxygen (%)	3.5									
9. NOx (hot) read/3% O_2 (ppm)*	—	—								
10. NO (hot) read/3% O_2 (ppm)*	—	—								
11. NO_2 (hot) read/3% O_2 (ppm)*	—	—								
12. NO (cold) read/3% O_2 (ppm)*	124	128								
13. Carbon Dioxide (%)	11.4									
14. Carbon Monoxide (ppm) uncor/cor*	4	4								
15. Hydrocarbon (ppm) uncor/cor*	—	—								
16. Sulfur Dioxide (ppm) uncor/cor*	0	0								
17. Smoke Spot (Bacharach)	—									
18. Atmos. Temp. (°F/°C) Avg	77/25									
19. Dew Point Temp. (°F/°C)	—									
20. Atmos. Pressure (in. Hg) Avg	29.64									
21. Relative Humidity (%)	—									
22.										
23.										
24.										
25.										
26.										
27.										
28.										
29.										
30.										

*Correction to 3% O_2 should not be performed if the value is measured on a wet basis.

Data Sheet 6002-2

MOBILE LABORATORY DATA　　　Test No. 10/7-1

Test No. 10/7-1 Date 10/7/82 Location SITE 2 Engr. BENSON

Unit No. 11 H13 Fuel Adsorber Gas RATED Capacity 14K bbl/day

Unit Type PROCESS HEATED Burner Type ZINK DBA-22 NATURAL DRAFT

1. Test No.	10/7-1					
2. Date	10/7/82					
3. Time	ALL DAY					
4. Load 10^6 BTU/HR	45.8					
5. Process Rate bbl/day	11308					
6. Flue Diam. or Size, ft	4.2					
7. Probe Position	STACK					
8. Oxygen (%)	3.9					
9. NOx (hot) read/3% O_2 (ppm)*	—	—				
10. NO (hot) read/3% O_2 (ppm)*	—	—				
11. NO_2 (hot) read/3% O_2 (ppm)*	—	—				
12. NO (cold) read/3% O_2 (ppm)*	118	124				
13. Carbon Dioxide (%)	11.2					
14. Carbon Monoxide (ppm) uncor/cor*	3	3				
15. Hydrocarbon (ppm) uncor/cor*	—	—				
16. Sulfur Dioxide (ppm) uncor/cor*	11	12				
17. Smoke Spot (Bacharach)	—					
18. Atmos. Temp. (°F/°C)	72/22					
19. Dew Point Temp. (°F/°C)	—					
20. Atmos. Pressure (in. Hg)	29.73					
21. Relative Humidity (%)	—					
22.						
23.						
24.						
25.						
26.						
27.						
28.						
29.						
30.						

*Correction to 3% O_2 should not be performed if the value is measured on a wet basis.

Data Sheet 6002-2

MOBILE LABORATORY DATA　　Test No. 10/8-1-5

Test No. 10/8-1-5 Date 10/8/82 Location SITE 2 Engr. BENSON

Unit No. 11H13 Fuel Adsorber Gas RATED Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

1. Test No.	10/8-1		10/8-2		10/8-3		10/8-4		10/8-5	
2. Date	10/8/82		—						—	
3. Time	0908-1003		1036-1238		1251-1415		1457-1552		1651-1738	
4. Load 10⁶ BTU/HR	48.5		——→							
5. Process Rate bbl/day	11460		——→							
6. Flue Diam. or Size, ft	4.2		——→							
7. Probe Position	STACK		——→							
8. Oxygen (%)	4.0		4.4		3.9		4.1		3.9	
9. NOx (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
10. NO (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
11. NO_2 (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
12. NO (cold) read/3% O_2 (ppm)*	124	131	97	105	94	99	79	84	66	69
13. Carbon Dioxide (%)	11.2		10.8		11.2		11.2		11.8	
14. Carbon Monoxide (ppm) uncor/cor*	7	7	5	5	2	2	4	4	7	7
15. Hydrocarbon (ppm) uncor/cor*	—	—	—	—	—	—	—	—	—	—
16. Sulfur Dioxide (ppm) uncor/cor*	0	0	0	0	2	2	1	1	11	12
17. Smoke Spot (Bacharach)	—		—		—		—		—	
18. Atmos. Temp. (°F/°C)	68/20		70/21		74/23		76/24		75/24	
19. Dew Point Temp. (°F/°C)	—		—		—		—		—	
20. Atmos. Pressure (in. Hg)	29.83		29.81		29.79		29.75		29.73	
21. Relative Humidity (%)	—		—		—		—		—	
22.										
23.										
24.										
25.										
26.										
27.										
28.										
29.										
30.										

*Correction to 3% O_2 should not be performed if the value is measured on a wet basis.

Data Sheet 6002-2

MOBILE LABORATORY DATA **Test No.** 10/12-1-3

Test No. 10/12-1-3 **Date** 10/12/82 **Location** SITE 2 **Engr.** BENSON

Unit No. 11H13 **Fuel** Absorber Gas **RATED Capacity** 14K bbl/day

Unit Type PROCESS HEATER **Burner Type** ZINK DBA-22 NATURAL DRAFT

1. Test No.	10/12-1		10/12-2		10/12-3					
2. Date	10/12/82		→							
3. Time	0855-0950		1029-1154		1743-1751					
4. Load 10⁶ BTU/HR	48.6		→							
5. Process Rate bbl/day	11460		→							
6. Flue Diam. or Size, ft	4.2		→							
7. Probe Position	STACK		→							
8. Oxygen (%)	3.8		4.5		3.2					
9. NOx (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—				
10. NO (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—				
11. NO_2 (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—				
12. NO (cold) read/3% O_2 (ppm)*	140	146	107	117	124	125				
13. Carbon Dioxide (%)	11.7		11.6		11.4					
14. Carbon Monoxide (ppm) uncor/cor*	4	4	4	4	6	6				
15. Hydrocarbon (ppm) uncor/cor*	—	—	—	—	—	—				
16. Sulfur Dioxide (ppm) uncor/cor*	2	2	4	2	2	2				
17. Smoke Spot (Bacharach)	—		—		—					
18. Atmos. Temp. (°F/°C)	67 / 19		—		—					
19. Dew Point Temp. (°F/°C)	—		—		—					
20. Atmos. Pressure (in. Hg)	29.71		—		—					
21. Relative Humidity (%)	—		—		—					
22.										
23.										
24.										
25.										
26.										
27.										
28.										
29.										
30.										

*Correction to 3% O_2 should not be performed if the value is measured on a wet basis.

Data Sheet 6002-2

MOBILE LABORATORY DATA

Test No. 10/13-1-4

Test No. 10/13-1-4 Date 10/13/82 Location SITE 2 Engr. BENSON

Unit No. 11 H 13 Fuel Absorber Gas RATED Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

1. Test No.	10/13-1		10/13-2		10/13-3		10/13-4			
2. Date	10/13/82									
3. Time	0831-0932		1109-1144		1237-1255		1401-1438			
4. Load 10^6 BTU/HR	44.1									
5. Process Rate bbl/day	11460									
6. Flue Diam. or Size, ft	4.2									
7. Probe Position	STACK									
8. Oxygen (%)	3.8		3.4		3.7		3.6			
9. NOx (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—		
10. NO (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—		
11. NO_2 (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—		
12. NO (cold) read/3% O_2 (ppm)*	122	128	114	117	126	131	133	138		
13. Carbon Dioxide (%)	11.6		11.3		10.4		12.3			
14. Carbon Monoxide (ppm) uncor/cor*	5	5	4	4	3	3	6	6		
15. Hydrocarbon (ppm) uncor/cor*	—	—	—	—	—	—	—	—		
16. Sulfur Dioxide (ppm) uncor/cor*	7	7	3	3	—	—	—	—		
17. Smoke Spot (Bacharach)	—		—		—		—			
18. Atmos. Temp. (°F/°C)	—		—		—		—			
19. Dew Point Temp. (°F/°C)	—		—		—		—			
20. Atmos. Pressure (in. Hg)	29.75		29.74		29.75		29.75			
21. Relative Humidity (%)	—		—		—		—			
22.										
23.										
24.										
25.										
26.										
27.										
28.										
29.										
30.										

*Correction to 3% O_2 should not be performed if the value is measured on a wet basis.

Data Sheet 6002-2

MOBILE LABORATORY DATA **Test No.** 10/14-1-3

Test No. 10/14-1-3 **Date** 10/14/82 **Location** SITE 2 **Engr.** BENSON

Unit No. 11 H 13 **Fuel** Adsorber Gas **RATED Capacity** 14 K bbl/day

Unit Type PROCESS HEATER **Burner Type** ZINK DBA-22 NATURAL DRAFT

1. Test No.	10/14-1		10/14-2		10/14-3					
2. Date	10/14/82		→		→					
3. Time	1517-1535		1614-1641		1710-1742					
4. Load 10⁶ BTU/HR	48.6		48.6		49.7					
5. Process Rate bbl/day	11460		→		→					
6. Flue Diam. or Size, ft	4.2		→		→					
7. Probe Position	STACK		→		→					
8. Oxygen (%)	2.6		4.1		4.1					
9. NOx (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—				
10. NO (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—				
11. NO_2 (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—				
12. NO (cold) read/3% O_2 (ppm)*	93	91	108	115	143	152				
13. Carbon Dioxide (%)	11.5		10.9		11.3					
14. Carbon Monoxide (ppm) uncor/cor*	6	6	7	7	7	7				
15. Hydrocarbon (ppm) uncor/cor*	—	—	—	—	—	—				
16. Sulfur Dioxide (ppm) uncor/cor*	—	—	—	—	—	—				
17. Smoke Spot (Bacharach)	—		—		—					
18. Atmos. Temp. (°F/°C)	—		—		—					
19. Dew Point Temp. (°F/°C)	—		—		—					
20. Atmos. Pressure (in. Hg)	—		—		—					
21. Relative Humidity (%)	—		—		—					
22.										
23.										
24.										
25.										
26.										
27.										
28.										
29.										
30.										

*Correction to 3% O_2 should not be performed if the value is measured on a wet basis.

Data Sheet 6002-2

MOBILE LABORATORY DATA

Test No. 10/15-1-5

Test No. 10/15-1-5 Date 10/15/82 Location SITE 2 Engr. BENSON

Unit No. 11HF Fuel Adsorber Gas RATED Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

1. Test No.	10/15-1		10/15-2		10/15-3		10/15-4		10/15-5	
2. Date	10/15/82		→							
3. Time	0857-0923		0935-0953		1021-1037		1056-1114		1130-1148	
4. Load 10^6 BTU/HR	51.3		51.3		50.2		→			
5. Process Rate bbl/day	11460		→							
6. Flue Diam. or Size, ft	4.2		→							
7. Probe Position	STACK		→							
8. Oxygen (%)	4.9		3.5		3.5		1.9		4.6	
9. NOx (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
10. NO (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
11. NO_2 (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
12. NO (cold) read/3% O_2 (ppm)*	116	130	104	107	74	76	58	55	83	91
13. Carbon Dioxide (%)	10.7		11.3		11.2		11.9		10.6	
14. Carbon Monoxide (ppm) uncor/cor*	5	5	4	4	5	5	6	6	5	5
15. Hydrocarbon (ppm) uncor/cor*	—	—	—	—	—	—	—	—	—	—
16. Sulfur Dioxide (ppm) uncor/cor*	2	2	1	1	2	2	3	3	3	3
17. Smoke Spot (Bacharach)	—		—		—		—		—	
18. Atmos. Temp. (°F/°C)	63/17		64/18		66/19		67/19		—	
19. Dew Point Temp. (°F/°C)	—		—		—		—		—	
20. Atmos. Pressure (in. Hg)	29.79		29.79		29.81		29.81		—	
21. Relative Humidity (%)	—		—		—		—		—	
22.										
23.										
24.										
25.										
26.										
27.										
28.										
29.										
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*Correction to 3% O_2 should not be performed if the value is measured on a wet basis.

Data Sheet 6002-2

MOBILE LABORATORY DATA

Test No. 10/18-1-4

Test No. 10/18-1-4 Date 10/18/82 Location SITE 2 Engr. BENSON

Unit No. 11H13 Fuel Adsorber Gas RATED Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

1. Test No.	10/18-1		10/18-1A		10/18-2		10/18-3		10/18-4	
2. Date	10/18/82		→							
3. Time	0946-1022		1240-1257		1432-1529		1630-1707		1729-1806	
4. Load 10⁶ BTU/HR	45.4		→		44.3		←→			
5. Process Rate bbl/day	11363		→		11420		→			
6. Flue Diam. or Size, ft	4.2		→							
7. Probe Position	STACK		→							
8. Oxygen (%)	3.7		4.0		3.6		3.9		3.4	
9. NOx (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
10. NO (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
11. NO_2 (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
12. NO (cold) read/3% O_2 (ppm)*	122	127	127	134	116	120	113	119	97	99
13. Carbon Dioxide (%)	11.3		11.2		11.4		11.2		11.3	
14. Carbon Monoxide (ppm) uncor/cor*	4	4	6	6	6	6	6	6	6	6
15. Hydrocarbon (ppm) uncor/cor*	—	—	—	—	—	—	—	—	—	—
16. Sulfur Dioxide (ppm) uncor/cor*	—	—	—	—	—	—	3	3	3	3
17. Smoke Spot (Bacharach)	—		—		—		—		—	
18. Atmos. Temp. (°F/°C)	63/17		71/22		78/26				72/22	
19. Dew Point Temp. (°F/°C)	—		—		—		—		—	
20. Atmos. Pressure (in. Hg)	29.76		29.72		29.71				29.69	
21. Relative Humidity (%)	—		—		—		—		—	
22.										
23.										
24.										
25.										
26.										
27.										
28.										
29.										
30.										

*Correction to 3% O_2 should not be performed if the value is measured on a wet basis.

Data Sheet 6002-2

MOBILE LABORATORY DATA

Test No. 10/19-1-5

Test No. 10/19-1-5 Date 10/19/82 Location SITE 2 Engr. BENSON

Unit No. 11H13 Fuel Adsorber Gas RATED Capacity 14K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

1. Test No.	10/19-1		10/19-2		10/19-3		10/19-4		10/19-5	
2. Date	10/19/82		→							
3. Time	0924-1044		1213-1248		1327-1402		1435-1511		1624-1639	
4. Load 10^6 BTU/HR	43.7		→							
5. Process Rate BBL/day	10532		→							
6. Flue Diam. or Size, ft	4.2		→							
7. Probe Position	STACK		→							
8. Oxygen (%)	4.4		3.7		3.9		3.8		4.0	
9. NOx (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
10. NO (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
11. NO_2 (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
12. NO (cold) read/3% O_2 (ppm)*	127	138	115	120	102	107	102	107	140	148
13. Carbon Dioxide (%)	11.1		11.2		11.0		10.7		10.7	
14. Carbon Monoxide (ppm) uncor/cor*	5	5	5	5	5	5	5	5	5	5
15. Hydrocarbon (ppm) uncor/cor*	—	—	—	—	—	—	—	—	—	—
16. Sulfur Dioxide (ppm) uncor/cor*	2	2	2	2	1	1	—	—	—	—
17. Smoke Spot (Bacharach)	—		—		—		—		—	
18. Atmos. Temp. (°F/°C)	67/19		69/21		73/23		76/24		78/26	
19. Dew Point Temp. (°F/°C)	—		—		—		—		—	
20. Atmos. Pressure (in. Hg)	29.76		29.76		29.76		29.74		29.74	
21. Relative Humidity (%)	—		—		—		—		—	
22.										
23.										
24.										
25.										
26.										
27.										
28.										
29.										
30.										

*Correction to 3% O_2 should not be performed if the value is measured on a wet basis.

Data Sheet 6002-2

MOBILE LABORATORY DATA

Test No. 10/20-1-5

Test No. 10/20-1-5 Date 10/20/82 Location SITE 2 Engr. BENSON

Unit No. 11 H13 Fuel Absorber Gas RATED Capacity 14K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

1. Test No.	10/20-1		10/20-2		10/20-3		10/20-4		10/20-5	
2. Date	10-20-82		→							
3. Time	0908-0952		1133-1206		1345-1421		1438-1514		1625-1632	
4. Load x 10^6 BTU/hr	43.1		43.1		43.1		43.1		43.1	
5. Process Rate bbl/day	10530		10530		10530		10530		—	
6. Flue Diam. or Size, ft	4.2		4.2		4.2		4.2		4.2	
7. Probe Position	STACK		→							
8. Oxygen (%)	4.1		3.5		4.0		3.6		3.9	
9. NOx (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
10. NO (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
11. NO_2 (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
12. NO (cold) read/3% O_2 (ppm)*	129	137	124	128	115	122	102	106	130	137
13. Carbon Dioxide (%)	10.9		11.1		11.2		10.9		10.7	
14. Carbon Monoxide (ppm) uncor/cor*	5		5		5		5		5	
15. Hydrocarbon (ppm) uncor/cor*	—	—	—	—	—	—	—	—	—	—
16. Sulfur Dioxide (ppm) uncor/cor*	2		4		4		2		—	
17. Smoke Spot (Bacharach)	—		—		—		—		—	
18. Atmos. Temp. (°F/°C)	65/18		68/20		72/22		74/23		76/24	
19. Dew Point Temp. (°F/°C)	—		—		—		—		—	
20. Atmos. Pressure (in. Hg)	29.82		29.82		29.80		29.82		29.82	
21. Relative Humidity (%)	—		—		—		—		—	
22.										
23.										
24.										
25.										
26.										
27.										
28.										
29.										
30.										

*Correction to 3% O_2 should not be performed if the value is measured on a wet basis.

Data Sheet 6002-2

MOBILE LABORATORY DATA

Test No. 10/21-1-5

Test No. 10/21-1-5 Date 10/21/82 Location SITE 2 Engr. BENSON

Unit No. 11 H13 Fuel Adsorder Gas RATED Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

1. Test No.	10/21-1		10/21-2		10/21-3		10/21-4		10/21-5	
2. Date	10-21-82		→							
3. Time	1155-1213		1225-1329		1401-1449		1524-1555		1620-1651	
4. Load 10⁶ BTU/HR	43.8		43.8		43.3		45.9		42.3	
5. Process Rate bbl/day	11456		11456		11512		11512		1152	
6. Flue Diam. or Size, ft	4.2		→							
7. Probe Position	STACK		→							
8. Oxygen (%)	1.8		3.8		1.4		5.7		3.8	
9. NOx (hot) read/3% O_2 (ppm)*	–	–	–	–	–	–	–	–	–	–
10. NO (hot) read/3% O_2 (ppm)*	–	–	–	–	–	–	–	–	–	–
11. NO_2 (hot) read/3% O_2 (ppm)*	–	–	–	–	–	–	–	–	–	–
12. NO (cold) read/3% O_2 (ppm)*	131	123	93	97	68	62	106	125	66	69
13. Carbon Dioxide (%)	12.0		11.5		12.0		10.2		11.0	
14. Carbon Monoxide (ppm) uncor/cor*	6	6	5	5	5	5	4	4	5	5
15. Hydrocarbon (ppm) uncor/cor*	–	–	–	–	–	–	–	–	–	–
16. Sulfur Dioxide (ppm) uncor/cor*	6	6	2	2	31	28	–	–	–	–
17. Smoke Spot (Bacharach)	–		–		–		–		–	
18. Atmos. Temp. (°F/°C)	–		–		–		–		–	
19. Dew Point Temp. (°F/°C)	–		–		–		–		–	
20. Atmos. Pressure (in. Hg)	–		–		–		–		–	
21. Relative Humidity (%)	–		–		–		–		–	
22.										
23.										
24.										
25.										
26.										
27.										
28.										
29.										
30.										

*Correction to 3% O_2 should not be performed if the value is measured on a wet basis.

a Sheet 6002-2

MOBILE LABORATORY DATA **Test No.** 10/26-6-8

Test No. 10/21-6-8 **Date** 10/21/82 **Location** SITE 2 **Engr.** BENSON

Unit No. 11H13 **Fuel** Adsorber Gas **RATED Capacity** 14K bbl/day

Unit Type PROCESS HEATER **Burner Type** ZINK DBA-22 NATURAL DRAFT

1. Test No.	10/21-6		10/21-5R		10/21-7		10/21-8			
2. Date	10/21/82		10/21/82		10/21/82		10/21/82			
3. Time	1732-1759		1826-1838		1848-1906		1920-1938			
4. Load 10^6 BTU/HR	43.3		—		44.8		44.8			
5. Process Rate bbl/day	11512		—		11548		11548			
6. Flue Diam. or Size, ft	4.2		→							
7. Probe Position	STACK		→							
8. Oxygen (%)	1.9		3.6		5.5		3.3			
9. NOx (hot) read/3% O_2 (ppm)*	–	–	–	–	–	–	–	–		
10. NO (hot) read/3% O_2 (ppm)*	–	–	–	–	–	–	–	–		
11. NO_2 (hot) read/3% O_2 (ppm)*	–	–	–	–	–	–	–	–		
12. NO (cold) read/3% O_2 (ppm)*	63	59	70	72	79	92	106	108		
13. Carbon Dioxide (%)	11.9		11.5		10.5		11.6			
14. Carbon Monoxide (ppm) uncor/cor*	5	–	4	4	4	4	4	4		
15. Hydrocarbon (ppm) uncor/cor*	–	–	–	–	–	–	–	–		
16. Sulfur Dioxide (ppm) uncor/cor*	3	–	2	2	4	4	7	7		
17. Smoke Spot (Bacharach)	—		—		—		—			
18. Atmos. Temp. (°F/°C)	—		—		—		—			
19. Dew Point Temp. (°F/°C)	—		—		—		—			
20. Atmos. Pressure (in. Hg)	—		—		—		—			
21. Relative Humidity (%)	—		—		—		—			
22.										
23.										
24.										
25.										
26.										
27.										
28.										
29.										
30.										

*Correction to 3% O_2 should not be performed if the value is measured on a wet basis.

Data Sheet 6002-2

MOBILE LABORATORY DATA Test No. 10/25-1-5

Test No. 10/25-1-5 Date 10/25/82 Location SITE 2 Engr. BENSON

Unit No. 11H13 Fuel Adsorber Gas RATED Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

1. Test No.	10/25-1		10/25-2		10/25-3		10/25-4		10/25-5	
2. Date	10/25/82		→							
3. Time	0859-0916		1021-1058		1123-1141		1217-1245		1308-1336	
4. Load 10⁶ BTU/HR	33.2		28.8		→					
5. Process Rate bbl/day	7950		→							
6. Flue Diam. or Size, ft	4.2		→							
7. Probe Position	STACK		→							
8. Oxygen (%)	8.1		5.7		2.5		3.8		2.0	
9. NOx (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
10. NO (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
11. NO_2 (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
12. NO (cold) read/3% O_2 (ppm)*	91	127	96	113	91	89	87	91	71	67
13. Carbon Dioxide (%)	~6.9		10.2		11.7		11.0		12.0	
14. Carbon Monoxide (ppm) uncor/cor*	1	1	19	22	8	8	7	7	5	5
15. Hydrocarbon (ppm) uncor/cor*	—	—	—	—	—	—	—	—	—	—
16. Sulfur Dioxide (ppm) uncor/cor*	29	40	10	12	4	4	7	7	3	3
17. Smoke Spot (Bacharach)	—		—		—		—		—	
18. Atmos. Temp. (°F/°C)	65/18		65/18		—		69/21		73/23	
19. Dew Point Temp. (°F/°C)	—		—		—		—		—	
20. Atmos. Pressure (in. Hg)	29.80		29.79				29.79		29.79	
21. Relative Humidity (%)	—		—		—		—		—	
22.										
23.										
24.										
25.										
26.										
27.										
28.										
29.										
30.										

*Correction to 3% O_2 should not be performed if the value is measured on a wet basis.

Data Sheet 6002-2

MOBILE LABORATORY DATA Test No. 10/25-6-9

Test No. 10/25-6-9 Date 10/25/82 Location SITE 2 Engr. BENSON

Unit No. 11H13 Fuel Adsorber Gas RATED Capacity 14 K BBl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

1. Test No.	10/25-6		10/25-7		10/25-8		10/25-7R		10/25-9	
2. Date	10/25/82		————————→							
3. Time	1400-1431		1457-1527		1547-1616		1639-1649		1728-1738	
4. Load 10⁶ BTU/HR	28.8		————————→							
5. Process Rate bbl/day	7950		————————→							
6. Flue Diam. or Size, ft	4.2		————————→							
7. Probe Position	STACK		————————→							
8. Oxygen (%)	6.7		4.1		2.3		4.4		5.9	
9. NOx (hot) read/3% O_2 (ppm)*	–	–	–	–	–	–	–	–	–	–
10. NO (hot) read/3% O_2 (ppm)*	–	–	–	–	–	–	–	–	–	–
11. NO_2 (hot) read/3% O_2 (ppm)*	–	–	–	–	–	–	–	–	–	–
12. NO (cold) read/3% O_2 (ppm)*	97	122	73	78	69	66	82	89	92	110
13. Carbon Dioxide (%)	9.8		10.8		10.8		10.8		10.1	
14. Carbon Monoxide (ppm) uncor/cor*	1	1	4	4	10	10	9	10	4	5
15. Hydrocarbon (ppm) uncor/cor*	–	–	–	–	–	–	–	–	–	–
16. Sulfur Dioxide (ppm) uncor/cor*	3	3	3	3	12	12	23	25	105	125
17. Smoke Spot (Bacharach)	–		–		–		–		–	
18. Atmos. Temp. (°F/°C)	–		–		–		–		–	
19. Dew Point Temp. (°F/°C)	–		–		–		–		–	
20. Atmos. Pressure (in. Hg)	–		–		–		–		–	
21. Relative Humidity (%)	–		–		–		–		–	
22.										
23.										
24.										
25.										
26.										
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28.										
29.										
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*Correction to 3% O_2 should not be performed if the value is measured on a wet basis.

Data Sheet 6002-2

MOBILE LABORATORY DATA Test No. 10/26-1-5

Test No. 10/26-1-5 Date 10/26/82 Location SITE 2 Engr. BENSON

Unit No. 11H13 Fuel Adsorber GAS RATED Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

1. Test No.	10/26-1		10/26-2		10/26-3		10/27-4		10/26-5	
2. Date	10/26/82		→							
3. Time	0851-0912		CO LIMIT →						1313-1342	
4. Load 10^6 BTU/Hr	43.8		→							
5. Process Rate bbl/day	11455		→							
6. Flue Diam. or Size, ft	4.2		→							
7. Probe Position	STACK		→							
8. Oxygen (%)	1.9		0.8		0.8		0.8		2.0	
9. NOx (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
10. NO (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
11. NO_2 (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
12. NO (cold) read/3% O_2 (ppm)*	189	178	105	90	65	58	79	70	95	90
13. Carbon Dioxide (%)	12.0		—		—		—		12.0	
14. Carbon Monoxide (ppm) uncor/cor*	2	2	21	19	24	21	21	19	0	0
15. Hydrocarbon (ppm) uncor/cor*	—	—	—	—	—	—	—	—	—	—
16. Sulfur Dioxide (ppm) uncor/cor*	—	—	—	—	—	—	—	—	1853	1755
17. Smoke Spot (Bacharach)	—		—		—		—		—	
18. Atmos. Temp. (°F/°C)	—		—		—		—			
19. Dew Point Temp. (°F/°C)	—		—		—		—		—	
20. Atmos. Pressure (in. Hg)	—		—		—		—			
21. Relative Humidity (%)	—		—		—		—		—	
22.										
23.										
24.										
25.										
26.										
27.										
28.										
29.										
30.										

*Correction to 3% O_2 should not be performed if the value is measured on a wet basis.

Data Sheet 6002-2

MOBILE LABORATORY DATA

Test No. 10/25-10-11

Test No. 10/25-10-11 Date 10/25/82 Location SITE 2 Engr. BENSON

Unit No. 11 H13 Fuel Adsorber Gas RATED Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

1. Test No.	10/25-10		10/25-11							
2. Date	10/25/82		10/25/82							
3. Time	1754-1805		1818-1830							
4. Load 10^6 BTU/HR	28.8		28.8							
5. Process Rate bbl/day	7950		7950							
6. Flue Diam. or Size, ft	4.2		4.2							
7. Probe Position	STACK		STACK							
8. Oxygen (%)	3.7		4.1							
9. NOx (hot) read/3% O_2 (ppm)*	—	—	—	—						
10. NO (hot) read/3% O_2 (ppm)*	—	—	—	—						
11. NO_2 (hot) read/3% O_2 (ppm)*	—	—	—	—						
12. NO (cold) read/3% O_2 (ppm)*	133	138	143	152						
13. Carbon Dioxide (%)	11.3		11.1							
14. Carbon Monoxide (ppm) uncor/cor*	4	4	5	5						
15. Hydrocarbon (ppm) uncor/cor*	—	—	—	—						
16. Sulfur Dioxide (ppm) uncor/cor*	496	516	772	822						
17. Smoke Spot (Bacharach)	—		—							
18. Atmos. Temp. (°F/°C)	—		—							
19. Dew Point Temp. (°F/°C)	—		—							
20. Atmos. Pressure (in. Hg)	—		—							
21. Relative Humidity (%)	—		—							
22.										
23.										
24.										
25.										
26.										
27.										
28.										
29.										
30.										

*Correction to 3% O_2 should not be performed if the value is measured on a wet basis.

Data Sheet 6002-2

MOBILE LABORATORY DATA **Test No.** 10/26-6-1R

Test No. 10/26-6-1R **Date** 10/26/82 **Location** SITE 2 **Engr.** BENSON

Unit No. 11H13 **Fuel** Adsorber Gas **RATED Capacity** 14K bbl/day

Unit Type PROCESS HEATER **Burner Type** ZINK DBA-22 NATURAL DRAFT

1. Test No.	10/26/6		10/26-7		10/26-1R					
2. Date	10/26/82		→		→					
3. Time	1402-1431		1458-1527		1550-1605					
4. Load	43.8		43.8		36.1					
5. Process Rate	11455		→		→					
6. Flue Diam. or Size, ft	4.2		→		→					
7. Probe Position	STACK		→		→					
8. Oxygen (%)	3.6		5.7		2.5					
9. NOx (hot) read/3% O_2 (ppm)*	–	–	–	–	–	–				
10. NO (hot) read/3% O_2 (ppm)*	–	–	–	–	–	–				
11. NO_2 (hot) read/3% O_2 (ppm)*	–	–	–	–	–	–				
12. NO (cold) read/3% O_2 (ppm)*	120	124	133	157	206	200				
13. Carbon Dioxide (%)	11.0		10.1		10.8					
14. Carbon Monoxide (ppm) uncor/cor*	2	2	6	7	15	15				
15. Hydrocarbon (ppm) uncor/cor*	–	–	–	–	–	–				
16. Sulfur Dioxide (ppm) uncor/cor*	1624	1680	1536	1807	1786	1738				
17. Smoke Spot (Bacharach)	–		–		–					
18. Atmos. Temp. (°F/°C)	62/17		62/17		64/18					
19. Dew Point Temp. (°F/°C)	–		–		–					
20. Atmos. Pressure (in. Hg)	29.75		29.76		29.80					
21. Relative Humidity (%)	–		–		–					
22.										
23.										
24.										
25.										
26.										
27.										
28.										
29.										
30.										

*Correction to 3% O_2 should not be performed if the value is measured on a wet basis.

Data Sheet 6002-2

UNIT OPERATING DATA

Test No. 10/5-1 Date 10/5/82 Location SITE 2 Engr. BENSON

Unit No. 11H13 Fuel Absorber Gas RATED Capacity 14K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

Test Description: AS FOUND BASELINE

1. Test Number	10/5-1				
2. Date	10/5/82				
3. Time	1445				
4. Load x 10^6 Btu/hr	—				
5. Process Rate x 1847.7 bbl/d	5.1/9423				
6. Crude T_{in} (°F)	370				
7. Crude T_{out} (°F) East	655				
8. Crude T_{out} (°F) West	645				
9. Crude P_{in} (psig) East	100				
. Crude P_{in} (psig) West	105				
11. Crude P_{out} (psig)	25.5				
Reabsorber gas in 12. x 205.856 (10^3 scf/d)	3.8/782.25				
Natural gas in 13. x 169.044 (10^3 scf/d)	0/				
14. Fuel oil in (P) psig	—				
15. GAS Fuel P/~~steam~~ P (psig)	9				
16. Burner #1	7.0				
17. Burner #2	7.8				
18. Burner #3	8.8				
19. Burner #4	9.2				
20. Burner #5	7.6				
21. Burner #6	8.4				

Oil Flow (bbl/d)

UNIT OPERATING DATA - CONTINUED

Test No. 10/5-1 Date 10/5/82 Location Site2 Engr. BENSON

Unit No. 11H13 Fuel Absorber Gas RATED Capacity 14 K bbl/day

Unit Type Refinery Process Heater Burner Type Zink DBA-22 Natural Draft

Test Description: AS FOUND BASELINE

	1445				
22. Tube Skin Temperatures (°F)					
23. 13A	—				
24. 15A	—				
25. 20A	—				
26. 25A	—				
27. 13B	—				
28. 15B	—				
29. 20B	—				
30. 25B	—				
31. Staging Height (ft)	—				
32. Staging Air P (iwg)	—				
33. Staging Air T (°F)	—				
34. Stack T (°F)	725				
35. Fuel Oil T (°F)	—				
36. Stack Damper (% open)	100				
37. Bottom Furnace P (iwg)	—				
38. Convective P (iwg)	—				
39. Stack P (iwg)	—				
40. Air Registers (% open)	1 | 2 | 3 | 4 | 5 | 6 50 | 70 | 0 | 70 | 10 | 50				
41. Crude API Gravity	22.5				
42. Flame Observations					
43. Other Observations					

UNIT OPERATING DATA

Test No. 10/6-1 Date 10/6/82 Location SITE 2 Engr. BENSON

Unit No. 11H13 Fuel Absorber Gas RATED Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL HEATER

Test Description: BASE LINE AS FOUND

1. Test Number	10/6-1	→	→	→	→
2. Date	10/6/82	→	→	→	→
3. Time	0900	1045	1200	1330	1500
4. Load x 10^6 Btu/hr	46.7	→	→	→	→
5. Process Rate x 1847.7 bbl/d	6.17/11400	6.17/11400	6.18/11420	6.18/11420	6.15/11360
6. Crude T_{in} (°F)	345	350	→	→	353
7. Crude T_{out} (°F) East	648	643	644	646	642
8. Crude T_{out} (°F) West	657	657	653	658	658
9. Crude P_{in} (psig) East	123	123	125	122	113
. Crude P_{in} (psig) West	117	117	118	130	120
11. Crude P_{out} (psig)	29	30	30	31.5	30
12. Reabsorber gas in x 205.856 (10^3 scf/d)	4.4/905.77	→	→	→	4.3/885.2
13. Natural gas in x 169.044 (10^3 scf/d)	0/	→	→	→	→
14. Fuel oil in (P) psig	—	—	—	—	—
15. GAS Fuel P/steam P (psig)	—	—	—	—	—
16. Burner #1	10.7	11.7	11.5	10.8	10.0
17. Burner #2	11.6	12.0	11.8	12.2	11.8
18. Burner #3	13.1	13.0	12.7	13.4	12.6
19. Burner #4	13.5	13.6	13.2	13.5	12.0
20. Burner #5	11.9	12.2	11.9	12.0	11.6
21. Burner #6	12.5	12.8	12.4	12.6	12.2

Oil Flow (bbl/d)

Page 2

UNIT OPERATING DATA - CONTINUED

Test No. 10/6-1 Date 10/6/82 Location SITE 2 Engr. BENSON

Unit No. 11 H13 Fuel Absorber Gas Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

Test Description: BASELINE AS FOUND

10/6-1 →

22. Tube Skin Temperatures (°F)					
23. 13A	—	—	—	—	776
24. 15A	—	—	—	—	742
25. 20A	—	—	—	—	765
26. 25A	—	—	—	—	814
27. 13B	—	—	—	—	750
28. 15B	—	—	—	—	741
29. 20B	—	—	—	—	742
30. 25B	—	—	—	—	817
31. Staging Height (ft)	—	—	—	—	—
32. GAS PRES. IN ~~Staging Air P (iwg~~)	13	13	13	13.2	—
33. Staging Air T (°F)	—	—	—	—	—
34. Stack T (°F)	751	748	744	742	741
35. Fuel Oil T (°F)	—	—	—	—	—
36. Stack Damper (% open)	100	100	100	100	100
37. Bottom Furnace P (iwg)	—	—	—	—	—
38. Convective P (iwg)	—	—	—	—	—
39. Stack P (iwg)	—	—	—	—	—
40. Air Registers (% open)	50/40/30/80/80/LC				→
41. Crude API Gravity	22.5	22.5	22.5	22.5	22.5
42. Flame Observations	—	—	—	—	—
43. Other Observations	—	—	—	—	—

VIEW PORTS - #C CLOSED, #1 PARTIALLY CLOSED, #2-5 WIDE OPEN FOR BURNERS

UNIT OPERATING DATA

Test No. 10/6-1 Date 10/6/82 Location SITE 2 Engr. BENSON

Unit No. 11H13 Fuel Adsorber Gas RATED Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

Test Description: BASELINE AS FOUND

1. Test Number	10/6-1				
2. Date	10/6/82				
3. Time	1645				
4. Load x 10^6 Btu/hr	46.7				
5. Process Rate x 1847.7 bbl/d	6.12/11308				
6. Crude T_{in} (°F)	350				
7. Crude T_{out} (°F) East	647				
8. Crude T_{out} (°F) West	658				
9. Crude P_{in} (psig) East	112				
. Crude P_{in} (psig) West	120				
11. Crude P_{out} (psig)	30				
12. Reabsorber gas in x 205.856 (10^3 scf/d)	4.3/885.18				
13. Natural gas in x 169.044 (10^3 scf/d)	—				
14. Fuel oil in (P) psig	—				
15. Fuel P/steam P (psig)	—				
16. Burner #1	10.0				
17. Burner #2	11.2				
18. Burner #3	12.5				
19. Burner #4	12.0				
20. Burner #5	11.6				
21. Burner #6	12.2				

Oil Flow (bbl/d)

Page 2

UNIT OPERATING DATA - CONTINUED

Test No. 10/6-1 Date 10/6/82 Location Site 2 Engr. BENSON

Unit No. 11H13 Fuel Adsorber Gas RATED Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

Test Description: Baseline As Found

22. Tube Skin Temperatures (°F)					
23. 13A	—				
24. 15A	—				
25. 20A	—				
26. 25A	—				
27. 13B	—				
28. 15B	—				
29. 20B	—				
30. 25B	—				
31. Staging Height (ft)	—				
32. Staging Air P (iwg)	—				
33. Staging Air T (°F)	—				
34. Stack T (°F)	740				
35. Fuel Oil T (°F)	—				
36. Stack Damper (% open)	100				
37. Bottom Furnace P (iwg)	+.05 (?)				
38. Convective P (iwg)	+.12				
39. Stack P (iwg)	+.26				
40. Air Registers (% open)	—				
41. Crude API Gravity	22.5				
42. Flame Observations	—				
43. Other Observations	—				

UNIT OPERATING DATA

Test No. 10/7-1 Date 10/7/82 Location SITE 2 Engr. BENSON

Unit No. 11H13 Fuel Absorber Gas RATED Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

Test Description: BASELINE AS FOUND

1. Test Number	10/7-1	10/7-1	10/7-1	10/7-1	10/7-1
2. Date	10/7/82	→			
3. Time	0900	1000	1115	1200	1315
4. Load x 10^6 Btu/hr	45.8	→			
5. Process Rate x 1847.7 bbl/d	6.12/11308	→		6.15/11363	6.15/11363
6. Crude T_{in} (°F)	350	345	348	—	
7. Crude T_{out} (°F) East	658	660	657	659	656
8. Crude T_{out} (°F) West	643	644	643	644	640
9. Crude P_{in} (psig) East	112	110	115	110	110
. Crude P_{in} (psig) West	120	115	120	118	115
11. Crude P_{out} (psig)	29	28.5	29.5	29	29
12. Reabsorber gas in x 205.856 (10^3 scf/d)	4.3/885.18	→		4.35/895.47	4.3/885.18
13. Natural gas in x 169.044 (10^3 scf/d)	0/	→			
14. Fuel oil in (P) psig	—	—	—	—	—
15. Gas Fuel P/ P (psig)	13	→			
16. Burner #1	10.5	→			
17. Burner #2	12.2	11.8	→		
18. Burner #3	12.8	13.0	12.9	12.8	12.8
19. Burner #4	12.4	12.2	12.2	12.2	12.4
20. Burner #5	11.8	11.8	12.2	12.0	11.8
21. Burner #6	12.4	12.2	12.7	12.6	12.2

Oil Flow (bbl/d)

Page 2

UNIT OPERATING DATA - CONTINUED

Test No. 10/71 Date 10/7/82 Location site 2 Engr. BESON

Unit No. 11H13 Fuel Adsorber Gas RATED Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

Test Description: BASELINE AS FOUND

	0900	1000	1115	1200	1315
22. Tube Skin Temperatures (°F)					
23. 13A	—	—	—	—	—
24. 15A	—	—	—	—	—
25. 20A	—	—	—	—	—
26. 25A	—	—	—	—	—
27. 13B	—	—	—	—	—
28. 15B	—	—	—	—	—
29. 20B	—	—	—	—	—
30. 25B	—	—	—	—	—
31. Staging Height (ft)	—	—	—	—	—
32. Staging Air P (iwg)	—	—	—	—	—
33. Staging Air T (°F)	—	—	—	—	—
34. Stack T (°F)	—	—	—	—	—
35. Fuel Oil T (°F)	—	—	—	—	—
36. Stack Damper (% open)	100	100	100	100	100
37. Bottom Furnace P (iwg)	-.25	-.27	-.29	-.28	-.28
38. Convective P (iwg)	.07	.15	.12	.13	.15
39. Stack P (iwg)	.24	.22	.23	.20	.22
40. Air Registers (% open)	1 2 3 4 5 6 50 80 30 90 90 60	→			
41. Crude API Gravity	22.1	→			
42. Flame Observations	—	—	—	—	—
43. Other Observations	—	—	—	—	—

UNIT OPERATING DATA

Test No. 10/7-1 Date 10/7/82 Location SITE 2 Engr. BENSON

Unit No. 11H13 Fuel Absorber Gas RATED Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

Test Description: BASELINE AS FOUND

1. Test Number	10/7-1	10/7-1			
2. Date	10/7/82	10/7/82			
3. Time	1430	1600			
4. Load x 10^6 Btu/hr	45.8	45.8			
5. Process Rate x 1847.7 bbl/d	6.15/11308	6.15/11308			
6. Crude T_{in} (°F)	350	350			
7. Crude T_{out} (°F) East	654	654			
8. Crude T_{out} (°F) West	638	638			
9. Crude P_{in} (psig) East	112	110			
. Crude P_{in} (psig) West	120	118			
11. Crude P_{out} (psig)	29	28.5			
12. Reabsorber gas in x 205.856 (10^3 scf/d)	4.35/895.97	4.3/885.18			
13. Natural gas in x 169.044 (10^3 scf/d)	—	—			
14. Fuel oil in (P) psig	—	—			
15. Fuel P/~~steam~~ Gas P (psig)	13	13			
16. Burner #1	10.5	10			
17. Burner #2	11.4	11.8			
18. Burner #3	12.8	12.8			
19. Burner #4	12.2	12.2			
20. Burner #5	11.8	11.8			
21. Burner #6	12.4	12.4			

Oil Flow (bbl/d)

Page 2

UNIT OPERATING DATA - CONTINUED

Test No. 10/7-1 Date 10/7/82 Location SITE 2 Engr. BENSON

it No. 11 H13 Fuel Absorber GAS Capacity 14K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

Test Description: (BASELINE AS FOUND)

	10/7-1	10/7-1			
22. Tube Skin Temperatures (°F)					
23. 13A	757	762			
24. 15A	733	735			
25. 20A	751	753			
26. 25A	790	800			
27. 13B	736	735			
28. 15B	—	732			
29. 20B	757	756			
30. 25B	807	807			
31. Staging Height (ft)	0	0			
32. Staging Air P (iwg)	—	—			
33. Staging Air T (°F)	—	—			
34. Stack T (°F)	744	743			
35. Fuel Oil T (°F)	—	—			
36. Stack Damper (% open)	100	100			
37. Bottom Furnace P (iwg)	-.25	-.27			
38. Convective P (iwg)	0	.12			
39. Stack P (iwg)	.24 TO .34	.23			
40. Air Registers (% open)	—	—			
41. Crude API Gravity	22.1	22.1			
42. Flame Observations	—	—			
% O_2 (BOTTOM HTR / TOP HTR / STACK) 43. Other Observations	10/6.4/4.2	—			

UNIT OPERATING DATA

Test No. 10/8-1-4 Date 10/8/82 Location SITE 2 Engr. BENSON

Unit No. 11H13 Fuel Absorber Gas RATED Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

Test Description: (BASELINE AS FOUND) (ALL 24 4" PORTS OPEN REGS AS FOUND) (REGS 50% OPEN) (REGS 33% OPEN)

1. Test Number	10/8-1	10/8-2	10/8-2	10/8-3	10/8-4
2. Date	10/8/82	→	→	→	→
3. Time	0915	1055	1140	1315	1520
4. Load x 10^6 Btu/hr	48.5	→	→	→	→
5. Process Rate x 1847.7 bbl/d	6.2/11460	→	→	→	→
6. Crude T_{in} (°F)	343	345	345	350	350
7. Crude T_{out} (°F) East	653	651	654	656	654
8. Crude T_{out} (°F) West	640	642	644	643	638
9. Crude P_{in} (psig) East	118	122	118	118	120
. Crude P_{in} (psig) West	125	130	125	125	125
11. Crude P_{out} (psig)	30	29-32	30	31	31
12. Reabsorber gas in x 205.856 (10^3 scf/d)	4.4/905.8	→	→	→	→
13. Natural gas in x 169.044 (10^3 scf/d)	0	↔	↔	↔	↔
14. Fuel oil in (P) psig	—	—	—	—	—
15. GAS Fuel P/~~steam P~~ (psig)	14	13	13.8	13.5	13.5
16. Burner #1	11.0	11.5	11.5	11.0	11.0
17. Burner #2	12.4	13.0	12.8	12.4	12.4
18. Burner #3	13.4	13.8	13.3	13.4	13.2
19. Burner #4	13.8	14.0	13.8	13.8	13.9
20. Burner #5	12.6	13.2	12.6	12.6	12.6
21. Burner #6	13.2	13.8	13.4	13.0	13.2

Oil Flow (bbl/d)

Page 2

UNIT OPERATING DATA - CONTINUED

Test No. 10/8-1-4 Date 10/8/82 Location SITE 2 Engr. BENSON

.it No. 11 H13 Fuel Absorber Gas RATED Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

Test Description:	(BASELINE AS FOUND)	(ALL 24 4" PORTS OPEN REGS AS FOUND)		(REGS 50% OPEN)	(REGS 33% OPEN)
	10/8-1	10/8-2	10/8-2	10/8-3	10/8-4
22. Tube Skin Temperatures (°F)					
23. 13A	762	760	765	765	774
24. 15A	733	739	745	742	742
25. 20A	753	752	764	760	765
26. 25A	788	788	806	806	809
27. 13B	748	738	743	744	739
28. 15B	734	733	743	740	734
29. 20B	762	754	763	764	774
30. 25B	807	807	823	820	820
31. Staging Height (ft)	0	.4	.4	.4	.4
32. STATIC P TO BURNERS 1,2,3,4,5,6 ~~Staging Air P (iwg)~~	0	.01	—	.02	0.25
33. Staging Air T (°F)	—	—	—	—	—
34. Stack T (°F)	753	764	757	753	749
35. Fuel Oil T (°F)	—	—	—	—	—
36. Stack Damper (% open)	100	100	100	100	100
37. Bottom Furnace P (iwg)	-.30	-.15	-.18	-.18	-.23
38. Convective P (iwg)	.02	.20	0	0	0
39. Stack P (iwg)	.25	.29	.30	.1	.1
40. SECONDARY Air Registers (% open)	50/80/30/30/80/70	50/80/30/80/80/70	50/80/30/80/80/70	50	30
41. Crude API Gravity	22.1	22.1	22.1	22.1	22.1
42. Flame Observations					
43. %O2 (BOTTOM HTR/TOP HTR/STACK) Other Observations	10.5/6.6/4.2	10.5/7.6/4.8	—	9.5/7.4/4.2	9.2/6.6/4.3

UNIT OPERATING DATA

Test No. 10/8-5 Date 10/8/82 Location SITE 2 Engr. BENSON

Unit No. 11H13 Fuel Adsorber Gas RATED Capacity 14 k bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

Test Description: ALL REGS 10% OPEN

1. Test Number	10/8-5				
2. Date	10/8/82				
3. Time	1700				
4. Load x 10^6 Btu/hr	—				
5. Process Rate x 1847.7 bbl/d	6.2/11460				
6. Crude T_{in} (°F)	345				
7. Crude T_{out} (°F) East	652				
8. Crude T_{out} (°F) West	644				
9. Crude P_{in} (psig) East	122				
. Crude P_{in} (psig) West	130				
11. Crude P_{out} (psig)	32				
12. Reabsorber gas in x 205.856 (10^3 scf/d)	4.4/905.766				
13. Natural gas in x 169.044 (10^3 scf/d)	—				
14. Fuel oil in (P) psig	—				
15. GAS Fuel P/~~steam~~ P (psig)	13.8				
16. Burner #1	11.5				
17. Burner #2	12.6				
18. Burner #3	13.3				
19. Burner #4	14.1				
20. Burner #5	12.8				
21. Burner #6	13.0				

Oil Flow (bbl/d)

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UNIT OPERATING DATA - CONTINUED

Test No. 10/8-5 Date 10/8/82 Location SITE 2 Engr. BENSON

Unit No. 11H13 Fuel Absorber Gas RATED Capacity 14K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

Test Description: (REGS 10% OPEN)

	10/8-5				
22. Tube Skin Temperatures (°F)					
23. 13A	778				
24. 15A	745				
25. 20A	776				
26. 25A	812				
27. 13B	739				
28. 15B	729				
29. 20B	773				
30. 25B	815				
31. Staging Height (ft)	.4				
32. Staging Air P (iwg)	.27				
33. BURNER #6 INNER/OUTER ~~Staging Air~~ T (°F)	560/260				
34. Stack T (°F)	747				
35. Fuel Oil T (°F)	—				
36. Stack Damper (% open)	100				
37. Bottom Furnace P (iwg)	-.27				
38. Convective P (iwg)	.02				
39. Stack P (iwg)	.11				
40. Air Registers (% open)	10				
41. Crude API Gravity	22.1				
42. Flame Observations	—				
43. % O_2 (BOTTOM HTR/TOP HTR/STACK) Other Observations	10/6.8/4.2				

UNIT OPERATING DATA

ᵐᵃst No. 10/12-1-3 Date 10/12/82 Location SITE 2 Engr. BENSON

Unit No. 11 H13 Fuel Absorber Gas/Fuel Gas RATED Capacity 14 bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

Test Description: (BASELINE ALL VIEW PORTS CLOSED) (REGS 50% OPEN 4"PORTS OPEN) (REGS 80% OPEN 1¼ LANCES)

1. Test Number	10/12-1	10/12-2	10/12-3		
2. Date	10/12/82	→	→		
3. Time	0930	1045	1730		
4. Load x 10^6 Btu/hr	48.6	→	→		
5. Process Rate x 1847.7 bbl/d	6.2/11460	→	→		
6. Crude T_{in} (°F)	353	355	355		
7. Crude T_{out} (°F) East	650	652	654		
8. Crude T_{out} (°F) West	639	643	640		
9. Crude P_{in} (psig) East	122	120	128		
. Crude P_{in} (psig) West	130	128	135		
11. Crude P_{out} (psig)	32	32	30-36 (BIG SWING)		
12. Reabsorber gas in x 205.856 (10^3 scf/d)	4.0/823.42	→	→		
13. Natural gas in x 169.044 (10^3 scf/d)	.5/84.52	→	→		
14. Fuel oil in (P) psig	—	—	—		
15. GAS Fuel P/~~steam~~ P (psig)	12.5	12.8	12.5		
16. Burner #1	10	→	→		
17. Burner #2	10.8	11.8	11.6		
18. Burner #3	12.0	12.9	12.4		
19. Burner #4	12.4	13.0	12.8		
20. Burner #5	11.2	12.0	11.4		
21. Burner #6	11.8	12.2	12.0		

Oil Flow (bbl/d)

UNIT OPERATING DATA - CONTINUED

Test No. 10/12-1-3 Date 10/12/82 Location SITE 2 Engr. BENSON

Unit No. 11 H13 Fuel Absorber Gas/FUEL GAS RATED Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK BBA-22 NATURAL DRAFT

Test Description:

	(ALL VIEWPORTS CLOSED BASELINE) 10/12-1	(REGS 50% OPEN 4" PORTS OPEN) 10/12-2	(REGS 80% OPEN 1/4 LANCES) 10/12-3		
22. Tube Skin Temperatures (°F)					
23. 13A	760	762	757		
24. 15A	719	730	720		
25. 20A	757	755	753		
26. 25A	784	804	794		
27. 13B	742	751	754		
28. 15B	728	—	735		
29. 20B	766	776	769		
30. 25B	793	821	810		
31. Staging Height (ft)	0	.4	.4		
32. Staging Air P (iwg)	—	—	—		
33. Staging Air T (°F)	—	—	—		
34. Stack T (°F)	734	748	729		
35. Fuel Oil T (°F)	—	—	—		
36. Stack Damper (% open)	~100	~100	~100		
37. Bottom Furnace P (iwg)	-.34	-.21	-.35		
38. Convective P (iwg)	.02	0	.03		
39. Stack P (iwg)	.05	.06	.04		
40. Air Registers (% open)	80/80/100/100/100/80	50	80		
41. Crude API Gravity	22.4	22.4	22.4		
42. Flame Observations		BURNER #3 ERRATIC FLAME, BLOWOUT			
%O2 (BOTTOM HTR/TOP HTR/STACK) 43. Other Observations	—	8.8/7.1/4.5	10.5/4.9/3.8		

UNIT OPERATING DATA

Test No. 10/13-1-4 Date 10/13/82 Location SITE 2 Engr. BENSON

Unit No. 11H13 Fuel Absorber Gas/Fuel Gas RATED Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

Test Description: (REGS 10% OPEN 1¼" LANCES) (REG 38% OPEN 1¼" LANCES) (REGS 50% OPEN 1¼" LANCES) (BASELINE CAPS ON)

1. Test Number	10/13-1	10/13-2	10/13-3	10/13-4	
2. Date	10/13/82	→			
3. Time	0900	1030	1240	1400	
4. Load x 10^6 Btu/hr	44.1	→			
5. Process Rate x 1847.7 bbl/d	6.2/11460	→			
6. Crude T_{in} (°F)	350	355	→		
7. Crude T_{out} (°F) East	654	656	660	653	
8. Crude T_{out} (°F) West	637	640	680	639	
9. Crude P_{in} (psig) East	122	120	125	122	
. Crude P_{in} (psig) West	130	125	131	130	
11. Crude P_{out} (psig)	33	→			
12. Reabsorber gas in x 205.856 (10^3 scf/d)	4.0/823.42	→			
13. Natural gas in x 169.044 (10^3 scf/d)	0/	→			
14. Fuel oil in (P) psig	—	—	—	—	
15. GAS Fuel P/~~steam~~ P (psig)	12.8	13.0	12.6	12.5	
16. Burner #1	11.0	10.5	10.0	10.0	
17. Burner #2	12.6	11.8	11.6	11.4	
18. Burner #3	13.4	12.6	12.6	12.4	
19. Burner #4	13.4	13.0	13.2	13.0	
20. Burner #5	11.8	11.8	11.7	11.6	
21. Burner #6	12.6	12.4	12.5	11.8	

Oil Flow (bbl/d)

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UNIT OPERATING DATA - CONTINUED

Test No. 10/13-1-4 Date 10/14/82 Location SITE 2 Engr. BENSON

Unit No. 11 N13 Fuel Absorber GAS/FUEL GAS RATED Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type

Test Description:

	(REGS 10% OPEN 1¼" LANCES) 10/13-1	(REGS 33% OPEN 1¼" LANCES) 10/13-2	(REGS 50% OPEN 1¼" LANCES) 10/13-3	(BASELINE 4" CAPSON) 10/13-4	
22. Tube Skin Temperatures (°F)					
23. 13A	762	759	755	761	
24. 15A	722	719	715	726	
25. 20A	753	750	749	760	
26. 25A	805	785	786	792	
27. 13B	753	748	746	750	
28. 15B	738	730	728	731	
29. 20B	780	771	768	770	
30. 25B	820	804	797	804	
31. Staging Height (ft)	4	4	4	0	
32. Staging Air P (iwg)	—	—	—	—	
33. BURNER #3 TEMP ~~Staging Air T (°F)~~	1260	—	—	—	
34. Stack T (°F)	747	745	741	730	
35. Fuel Oil T (°F)	—	—	—	—	
36. Stack Damper (% open)	~100	~100	~100	~100	
37. Bottom Furnace P (iwg)	-.6	-.5	-.44	-.35	
38. Convective P (iwg)	.18	-.08	.025	.02	
39. Stack P (iwg)	.18	.02	.04	.07	
40. Air Registers (% open)	10	33	50	50	
41. Crude API Gravity	23.0	23.0	23.0	23.0	
42. Flame Observations	SHORT FLAME	—	—	—	
43. %O_2 (BOTTOM HTR/TOP HTR/STACK) Other Observations	9.5/6.8/4.2	10.5/6.6/4.0	—	10.0/6.6/3.8	

UNIT OPERATING DATA - CONTINUED

Test No. 10/14-1-3 Date 10/14/82 Location SITE 2 Engr. BENSON

Unit No. 11 H13 Fuel Absorber Gas RATED Capacity 14 K bbl/day

Unit Type CRUDE PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

Test Description:

	(REGS 50% OPEN 4" LANCES) 10/14-1	(REGS 50% OPEN 4" LANCES) 10/14-2	(REGS 50% OPEN BASELINE) 10/14-3		
22. Tube Skin Temperatures (°F)					
23. 13A	—	—	—		
24. 15A	—	—	—		
25. 20A	—	—	—		
26. 25A	—	—	—		
27. 13B	—	—	—		
28. 15B	—	—	—		
29. 20B	—	—	—		
30. 25B	—	—	—		
31. Staging Height (ft)	.4	.4	0		
32. Staging Air P (iwg)	-.18	-.15	—		
33. Staging Air T (°F)	—	—	—		
34. Stack T (°F)	707	—	735		
35. Fuel Oil T (°F)	—	—	—		
36. Stack Damper (% open)	~100	~100	~100		
37. Bottom Furnace P (iwg)	-.20	-.23	-.50		
38. Convective P (iwg)	.03	0	0		
39. Stack P (iwg)	.32	.07	.03		
40. Air Registers (% open)	50	→	→		
41. Crude API Gravity	23.0	→	→		
42. Flame Observations					
43. Other Observations					

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UNIT OPERATING DATA - CONTINUED

Test No. 10/14-1-3 Date 10/14/82 Location SITE 2 Engr. BENSON

Unit No. 11 H13 Fuel Absorber Gas RATED Capacity 14 K bbl/day

Unit Type CRUDE PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

Test Description:

	(REGS 50% OPEN 4" LANCES) 10/14-1	(REGS 50% OPEN 4" LANCES) 10/14-2	(REGS 50% OPEN BASELINE) 10/14-3		
22. Tube Skin Temperatures (°F)					
23. 13A	—	—	—		
24. 15A	—	—	—		
25. 20A	—	—	—		
26. 25A	—	—	—		
27. 13B	—	—	—		
28. 15B	—	—	—		
29. 20B	—	—	—		
30. 25B	—	—	—		
31. Staging Height (ft)	.4	.4	0		
32. Staging Air P (iwg)	-.18	-.15	—		
33. Staging Air T (°F)	—	—	—		
34. Stack T (°F)	707	—	735		
35. Fuel Oil T (°F)	—	—	—		
36. Stack Damper (% open)	~100	~100	~100		
37. Bottom Furnace P (iwg)	-.20	-.23	-.50		
38. Convective P (iwg)	.03	0	0		
39. Stack P (iwg)	.32	.07	.03		
40. Air Registers (% open)	50	→	→		
41. Crude API Gravity	23.0	→	→		
42. Flame Observations					
43. Other Observations					

UNIT OPERATING DATA

Test No. 10/15-1-5 Date 10/15/82 Location SITE 2 Engr. BENSON

Unit No. 11 H13 Fuel Absorber Gas RATED Capacity 14 k bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

Test Description: (REGS 50% OPEN BASELINE) (REGS 33% OPEN BASELINE) (REGS 33% OPEN 4% O$_2$)

1. Test Number	10/15-1	10/15-2	10/15-3	10/15-4	10/15-5
2. Date	10/15/82	→	→	→	→
3. Time	0900	0950	1030	1100	1130
4. Load x 10^6 Btu/hr	51.3	51.3	50.2	→	→
5. Process Rate x 1847.7 bbl/d	6.2/11460	→	→	→	→
6. Crude T_{in} (°F)	355	→	→	→	→
7. Crude T_{out} (°F) East	648	→	→	→	650
8. Crude T_{out} (°F) West	642	→	→	→	640
9. Crude P_{in} (psig) East	125	→	→	→	→
. Crude P_{in} (psig) West	118	→	→	→	→
11. Crude P_{out} (psig)	32	→	→	→	→
12. Reabsorber gas in x 205.856 (10^3 scf/d)	4.25/874.88	4.25/874.88	4.15/854.30	→	→
13. Natural gas in x 169.044 (10^3 scf/d)	.5/84.53	→	→	→	→
14. Fuel oil in (P) psig	—	—	—	—	—
15. GAS Fuel P/~~steam P~~ (psig)	12.5	→	→	→	→
16. Burner #1	10.5	10.0	→	→	→
17. Burner #2	11.7	11.4	→	→	→
18. Burner #3	12.8	12.2	→	→	→
19. Burner #4	13.5	12.8	→	→	→
20. Burner #5	12.0	11.4	→	→	→
21. Burner #6	12.6	12.0	→	→	→

Oil Flow (bbl/d)

UNIT OPERATING DATA - CONTINUED

Test No. 10/15-1-5 Date 10/15/82 Location SITE 2 Engr. BENSON

Unit No. 11 H13 Fuel Absorber Gas RATED Capacity 14K bbl/day

Unit Type CRUDE OIL PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT.

Test Description:	(REGS 50% OPEN BASELINE) 10/15-1	(REGS 33% OPEN BASELINE) 10/15-2	(REGS 33% OPEN 4" PORTS) 10/15-3	(REGS 33% OPEN, LEA 4" PORTS) 10/15-4	(REGS 33% OPEN 4" PORTS) 10/15-5
22. Tube Skin Temperatures (°F)					
23. 13A	763	—	—	—	—
24. 15A	724	—	—	—	—
25. 20A	755	—	—	—	—
26. 25A	788	—	—	—	—
27. 13B	750	—	—	—	—
28. 15B	—	—	—	—	—
29. 20B	768	—	—	—	—
30. 25B	788	—	—	—	—
31. Staging Height (ft)	0	0	.4	.4	.4
32. Staging Air P (iwg)	=	=	−.33 P_{static}	−.23 ΔP_v −.28 P_{static}	−.37 ΔP_v —
33. Staging Air T (°F)	—	—	—	—	—
34. Stack T (°F)	754	—	—	703	734
35. Fuel Oil T (°F)	—	—	—	—	—
36. Stack Damper (% open)	—	—	—	—	—
37. Bottom Furnace P (iwg)	−.55	−.67	−.27	−.22	−.35
38. Convective P (iwg)	.01	−.03	0	.15	.02
39. Stack P (iwg)	.05	.03	.09	.08	.10
40. Air Registers (% open)	50	33	33	33	33
41. Crude API Gravity	22.5	22.5	22.5	22.5	22.5
42. Flame Observations	—	—	—	—	—
43. Other Observations	—	—	—	—	—

UNIT OPERATING DATA

Test No. 10/18-1-4 Date 10/18/82 Location SITE 2 Engr. BENSON

Unit No. 11 H13 Fuel Absorber Gas RATED Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL HEATER

Test Description:	(REG 50% OPEN BASELINE)		(REGS 50% OPEN 3" LANCES)	(REGS 33% OPEN 3" LANCES)	(REGS 10% OPEN 3" LANCES)
1. Test Number	10/18-1	10/18-1a	10/18-2	10/18-3	10/18-4
2. Date	10/18/82	→	→	→	→
3. Time	1000	1255	1455	1650	1740
4. Load x 10^6 Btu/hr	45.4	44.3	→	→	→
5. Process Rate x 1847.7 bbl/d	6.15/11363	6.18/11420	→	→	→
6. Crude T_{in} (°F)	350	353	350	→	→
7. Crude T_{out} (°F) East	648	652	650	649	647
8. Crude T_{out} (°F) West	637	640	639	640	626
9. Crude P_{in} (psig) East	110	105	108	→	→
. Crude P_{in} (psig) West	115	112	115	→	→
11. Crude P_{out} (psig)	27.5	→	→	→	→
12. Reabsorber gas in x 205.856 (10^3 scf/d)	4.1/844.0	4.0/823.92	→	→	→
13. Natural gas in x 169.044 (10^3 scf/d)	0/	→	→	→	→
14. Fuel oil in (P) psig	—	—	—	—	—
15. Gas Fuel P/~~steam~~ P (psig)	12.5	12.0	→	→	→
16. Burner #1	10.0	→	→	→	→
17. Burner #2	11.4	10.8	10.8	11.0	11.2
18. Burner #3	12.2	11.8	11.7	12.0	12.0
19. Burner #4	12.8	12.2	→	→	12.4
20. Burner #5	11.2	10.9	10.8	11.2	11.0
21. Burner #6	11.8	12.4	11.4	11.6	11.6

Oil Flow (bbl/d)

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UNIT OPERATING DATA - CONTINUED

Test No. 10/18-1-4 Date 10/18/82 Location SITE 2 Engr. BENSON

..it No. 11 H13 Fuel Absorber GAS Capacity 19K bbl/day

Unit Type CRUDE OIL PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

Test Description:

	(REGS 50% OPEN BASELINE) 10/18-1	10/18-1a	(REGS 50% OPEN 3" LANCES) 10/18-2	(REGS 33% OPEN 3" LANCES) 10/18-3	(REGS 10% OPEN 3" LANCES) 10/18-4
22. Tube Skin Temperatures (°F)					
23. 13A	752	—	746	750	749
24. 15A	729	—	729	723	719
25. 20A	751	—	745	746	754
26. 25A	793	—	785	800	808
27. 13B	741	—	735	735	730
28. 15B	739	—	732	731	725
29. 20B	761	—	760	760	775
30. 25B	812	—	803	817	825
31. Staging Height (ft)	0	0	4	4	4
32. LANCE SKIN TEMP, BURNER 3 ~~Staging Air P (iwg)~~ (LANCE ON HEATER & SIDE)	—	—	1540	—	1650
33. INJECTION TEMP ~~Staging Air~~ T (°F)	—	—	790	970	1100 (I) 950 (O)
34. Stack T (°F)	722	717	718	723	—
35. P TO BURNER #6 VEL ~~Fuel Oil T (°F~~)	—	—	-.17 STATIC .07	-.23 .10	-.27 .17
36. Stack Damper (% open)	~100	~100	~100	~100	~100
37. Bottom Furnace P (iwg)	-.40	-.38	-.28	-.40	-.55
38. Convective P (iwg)	.03	.02	.10	.01	.01
39. Stack P (iwg)	.08	.02	.08 TO .20	.040(?)	.01
40. Air Registers (% open)	50	50	50	33	10
41. Crude API Gravity	20.8	20.8	20.8	20.8	20.8
42. Air P TO BURNER #5 / P TO BURNER #1 ~~Flame Observations~~	—	—	-.14 / -.17	—	—
43. O_2 % (BOTTOM HTR / TOP HTR / STACK) Other Observations	10.5 / 6.2 / 4.1	—	10.1 / 6.2 / 4.1	10.5 / 5.8 / 4.4	10.0 / 4.9 / 5.1

UNIT OPERATING DATA

Test No. 10/19-1-5 Date 10/19/82 Location SITE 2 Engr. BENSON

Unit No. 11H13 Fuel Absorber Gas RATED Capacity 19 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK BBA-22 NATURAL DRAFT

Test Description:	(REGS 50% open BASELINE)	(REGS 50% OPEN 3" LANCES)	(REGS 33% OPEN 3" LANCES)	(REGS 10% open 3" LANCES)	(REGS 50% OPEN BASELINE)
1. Test Number	10/19-1	10/19-2	10/19-3	10/19-4	10/19-5
2. Date	10/19/82	→	→	→	→
3. Time	1000	1230	1345	1450	1630
4. Load x 10^6 Btu/hr	43.7	→	→	→	→
5. Process Rate x 1847.7 bbl/d	5.7/10532	→	→	→	→
6. Crude T_{in} (°F)	350	355	→	→	→
7. Crude T_{out} (°F) East	643	652	656	655	650
8. Crude T_{out} (°F) West	643	640	638	637	640
9. Crude P_{in} (psig) East	110	105	→	→	→
. Crude P_{in} (psig) West	118	110	→	→	→
11. Crude P_{out} (psig)	27.5	27.5	27.0	27.5	27.0
12. Reabsorber gas in x 205.856 (10^3 scf/d)	3.95/813.13	→	→	→	→
13. Natural gas in x 169.044 (10^3 scf/d)	0/	→	→	→	→
14. Fuel oil in (P) psig	—	—	—	—	—
15. GAS Fuel P/~~steam P~~ (psig)	11.0	11.0	11.5	11.5	11.0
16. Burner #1	9.5	9.0	→	→	→
17. Burner #2	10.0	10.0	10.2	→	→
18. Burner #3	10.8	11.0	11.2	11.1	11.1
19. Burner #4	11.6	→	→	11.4	11.4
20. Burner #5	10.0	10.2	10.0	→	→
21. Burner #6	11.0	10.8	10.8	10.5	10.5

Oil Flow (bbl/d)

Page 2

UNIT OPERATING DATA - CONTINUED

Test No. 10/19-1-5 Date 10/19/82 Location SITE 2 Engr. BENSON

Unit No. 11 H 13 Fuel Absorber Gas Capacity 14 K bbl/day

Unit Type CRUDE OIL PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

Test Description:

	(BASELINE REGS 50% OPEN) 10/19-1	(REGS 50% OPEN 3" LANCES) 10/19-2	(REGS 33% OPEN 3" LANCES) 10/19-3	(REGS 10% OPEN 3" LANCES) 10/19-4	(REGS 50% OPEN BASELINE) 10/19-5
22. Tube Skin Temperatures (°F)					
23. 13A	752	744	753	753	—
24. 15A	726	726	727	727	—
25. 20A	753	740	745	747	—
26. 25A	784	780	785	794	—
27. 13B	738	738	742	740	—
28. 15B	—	735	733	732	—
29. 20B	752	758	762	758	—
30. 25B	789	806	805	816	—
31. Staging Height (ft)	0	4	4	4	0
32. BURNER 3 FILM TEMP (°F) ~~Staging Air P (iwg)~~	—	1640	1630	1600	—
33. LANCE FLOW TEMP ~~Staging Air T~~ (°F)	—	1170	730	I O S 1100/750/970	—
34. Stack T (°F)	717	709	712	713	—
35. Fuel Oil T (°F)	—	—	—	—	—
36. Stack Damper (% open)	~100	~100	~100	~100	—
37. Bottom Furnace P (iwg)	-.35	-.25	-.37	-.48	—
38. Convective P (iwg)	0	.12	.04	-.08	—
39. Stack P (iwg)	.06	.02	.04	.01	—
40. Air Registers (% open)	50	50	33	10	—
41. Crude API Gravity	22.0	22.0	22.0	22.0	—
42. Flame Observations	—	—	—	—	—
43. Other Observations % O_2 (BOTTOM HTR/TOP HTR/STACK)	—	9.5/6.0/3.7	10.0/6.9/4.8	10.7/6.9/4.8	—

UNIT OPERATING DATA

Test No. 10/20-1-5 Date 10/20/8 Location SITE 2 Engr. BENSON

Unit No. 11H13 Fuel Absorber Gas RATED Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

Test Description: (REGS 50% OPEN BASELINE) (REGS 50% OPEN 3" LANCES) (REGS 33% OPEN 3" LANCES) (REGS 10% OPEN 3" LANCES) (REGS 50% OPEN BASELINE)

1. Test Number	10/20-1	10/20-2	10/20-3	10/20-4	10/20-5
2. Date	10/20/82	→			
3. Time	0930	1150	1400	1500	1630
4. Load x 10^6 Btu/hr	43.1	→			
5. Process Rate x 1847.7 bbl/d	5.7/10530	→			—
6. Crude T_{in} (°F)	350	340	345	345	—
7. Crude T_{out} (°F) East	648	645	649	650	—
8. Crude T_{out} (°F) West	642	644	642	641	—
9. Crude P_{in} (psig) East	110	110	108	105	—
. Crude P_{in} (psig) West	118	115	115	112	—
11. Crude P_{out} (psig)	28	27.5	27.5	27	—
12. Reabsorber gas in x 205.856 (10^3 scf/d)	4.0/823.42	→			—
13. Natural gas in x 169.044 (10^3 scf/d)	0	→			
14. Fuel oil in (P) psig	—	—	—	—	—
15. GAS Fuel P/~~steam P~~ (psig)	11.5	12.0	11.9	12.0	—
16. Burner #1	9.0	10.0	10.2	10.0	—
17. Burner #2	10.4	11.0	11.4	10.6	—
18. Burner #3	11.4	11.8	12.2	11.8	—
19. Burner #4	11.8	12.4	13.0	12.4	—
20. Burner #5	10.4	11.0	11.6	11.0	—
21. Burner #6	11.0	11.6	12.0	11.6	—

Oil Flow (bbl/d)

FOR TESTS 10/20-2, 10/20-3 AND 10/20-4 THE LANCES ARE ORIENTED TOWARD BURNER ℄. THE STAGING HEIGHT FOR THE LANCES IS 2 FEET

UNIT OPERATING DATA - CONTINUED

Test No. 10/20-1-5 Date 10/20/82 Location SITE 2 Engr. BENSEN

..it No. 11H13 Fuel Absorber GAS Capacity 14 kbbl/day

Unit Type CRUDE OIL PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

Test Description:	(BASELINE REG 50% OPEN) 10/20-1	(REGS 50% OPEN 3" LANCES) 10/20-2	(REGS 33% OPEN 3" LANCES) 10/20-3	(REGS 10% OPEN 3" LANCES) 10/20-4	(BASELINE REGS 50% OPEN) 10/20-5
22. Tube Skin Temperatures (°F)					
23. 13A	753	758	753	753	—
24. 15A	727	731	730	726	—
25. 20A	754	765	766	765	—
26. 25A	794	805	805	806	—
27. 13B	745	746	755	756	—
28. 15B	—	737	744	752	—
29. 20B	765	770	779	781	—
30. 25B	811	824	818	815	—
31. Staging Height (ft)	0	2	2	2	—
32. Staging Air P (iwg)	—	—	—	—	—
33. Staging Air T (°F) SKIN FILM TEMP.	—	1440	1440	—	—
34. Stack T (°F)	710	694	707	704	—
35. Fuel Oil T (°F)	—	—	—	—	—
36. Stack Damper (% open)	~100	~100	~100	~100	—
37. Bottom Furnace P (iwg)	-.41	-.30	-.41	-.53	—
38. Convective P (iwg)	.01	.06	.03	.09	—
39. Stack P (iwg)	.18	.04	.03	.09	—
40. Air Registers (% open)	50	50	33	10	—
41. Crude API Gravity	22.0	22.0	22.0	22.0	—
42. Flame Observations		(FLAME CONFINEMENT TO EACH BURNER, CENTER OF HEATER KEPT CLEAR OF FLAME)			—
43. Other Observations %O_2 (BOTTOM HTR/TOP HTR/STACK)	—	9.5/5.6/3.2	10/6.8/4.0	10/6.5/3.7	—

UNIT OPERATING DATA

Test No. 10/21-1-5 Date 10/21/82 Location SITE 2 Engr. BENSON

Unit No. 11H13 Fuel Adsorber Gas RATED Capacity 14K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

Test Description:	REGS 50% OPEN BASELINE	REGS 50% OPEN 4" PORTS 4% O_2	REGS 50% OPEN 4" PORTS LEA	REG 50% OPEN 4" PORTS HEA	REGS 10% OPEN 4" PORTS LEA
1. Test Number	10/21-1	10/21-2	10/21-3	10/21-4	10/21-5
2. Date	10/21/83	→	→	→	→
3. Time	1150	1230	1430	1520	1630
4. Load x 10^6 Btu/hr	43.8	→	→	→	→
5. Process Rate x 1847.7 bbl/d	6.2/11456	6.2/11456	6.23/11512	→	→
6. Crude T_{in} (°F)	345	345	335	350	348
7. Crude T_{out} (°F) East	650	650	654	646	651
8. Crude T_{out} (°F) West	636	636	640	646	639
9. Crude P_{in} (psig) East	110	→	→	112	110
. Crude P_{in} (psig) West	118	→	→	120	118
11. Crude P_{out} (psig)	27.5	→	→	→	→
12. Reabsorber gas in x 205.856 (10^3 scf/d)	4.3/885.18	4.3/885.18	4.25/874.89	4.5/926.35	4.15/854.3
13. Natural gas in x 169.044 (10^3 scf/d)	0/	→	→	→	→
14. Fuel oil in (P) psig	—	—	—	—	—
15. Gas Fuel P/~~steam~~ (psig)	13.5	13.5	13.8	15.5	14.5
16. Burner #1	11.0	11.0	11.0	14.0	12.5
17. Burner #2	12.2	12.8	12.8	14.6	13.4
18. Burner #3	13.2	14.0	14.0	15.6	14.2
19. Burner #4	13.2	14.0	14.0	15.6	14.2
20. Burner #5	12.4	12.4	12.4	14.4	13.0
21. Burner #6	13.0	13.0	13.0	15.2	13.6

Oil Flow (bbl/d)

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UNIT OPERATING DATA - CONTINUED

Test No. 10/21-1-5 Date 10/21/82 Location SITE 2 Engr. BENSON

Unit No. 11 H13 Fuel Absorber GAS RATED Capacity 14K bbl/day

Unit Type CRUDE PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

Test Description:

	(BASELINE REGS 50% OPEN) 10/21-1	(REGS 50% OPEN 4" PORTS ~ 42%) 10/21-2	(REGS 50% OPEN, 4" PORTS, LEA) 10/21-3	(REGS 50% OPEN 4" PORTS, HEA) 10/21-4	(REGS 10% OPEN 4" PORTS LEA) 10/21-5
22. Tube Skin Temperatures (°F)					
23. 13A	761	—	764	770	771
24. 15A	742	—	748	749	747
25. 20A	771	—	772	789	792
26. 25A	816	—	827	823	833
27. 13B	755	—	761	766	771
28. 15B	753	—	—	761	—
29. 20B	780	—	790	786	800
30. 25B	826	—	856	842	851
31. Staging Height (ft)	—	.4	.4	.4	.4
32. Staging Air P (iwg)	—	—	—	—	—
33. Staging Air T (°F)	—	—	—	—	—
34. Stack T (°F)	706	—	706	754	728
35. Fuel Oil T (°F)	—	—	—	—	—
36. Stack Damper (% open)	~100	~100	~100	~100	~100
37. Bottom Furnace P (iwg)	-.41	-.25	~.17	-.33	-.38
38. Convective P (iwg)	+0	—	+0	.08	.03
39. Stack P (iwg)	.35	—	.17	.03	.01
40. Air Registers (% open)	50	—	50	50	10
41. Crude API Gravity	22.3	22.3	22.3	22.3	22.3
42. Flame Observations	—	—	—	—	—
43. Other Observations	—	-	~6/4.7/1.8	TELEDYNE %O_2 DISCHARGED	X

UNIT OPERATING DATA

Test No. 10/21-6-8 Date 10/21/82 Location SITE 2 Engr. BENSON

Unit No. 11H13 Fuel Absorber Gas RATED Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

Test Description: (4" PORTS REGISTERS 10% OPEN)

1. Test Number	10/21-6	10/21-7	10/21-8		
2. Date	10/21/82	→	→		
3. Time	1752	1900	1930		
4. Load x 10^6 Btu/hr	43.3	44.8	44.8		
5. Process Rate x 1847.7 bbl/d	6.23/11512	6.25/11548	6.25/11548		
6. Crude T_{in} (°F)	345	→	→		
7. Crude T_{out} (°F) East	654	650	652		
8. Crude T_{out} (°F) West	633	638	637		
9. Crude P_{in} (psig) East	110	→	→		
. Crude P_{in} (psig) West	115	118	115		
11. Crude P_{out} (psig)	27.5	26.5	27.5		
12. Reabsorber gas in x 205.856 (10^3 scf/d)	4.25/874.89	4.4/905.77	4.4/905.77		
13. Natural gas in x 169.044 (10^3 scf/d)	0/	→	→		
14. Fuel oil in (P) psig	—	—	—		
15. Gas Fuel P/steam P (psig)	13.5	15.0	13.5		
16. Burner #1	10.4	11.0	12.0		
17. Burner #2	12.8	13.8	12.8		
18. Burner #3	13.6	15.0	13.6		
19. Burner #4	14.2	15.6	14.2		
20. Burner #5	12.6	14.0	12.8		
21. Burner #6	13.4	14.2	13.4		

Oil Flow (bbl/d)

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UNIT OPERATING DATA - CONTINUED

Test No. 10/21-6-8 Date 10/21/82 Location SITE 2 Engr. BENSON

Unit No. 11 H13 Fuel Absorber FUEL RATED Capacity 14 K bbl/day

Unit Type CRUDE PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

Test Description: (4" PORTS, REGISTERS 10% OPEN)

22. Tube Skin Temperatures (°F)	10/21-6	10/21-7	10/21-8		
23. 13A	764	767	781		
24. 15A	747	745	746		
25. 20A	794	787	790		
26. 25A	827	826	848		
27. 13B	778	772	775		
28. 15B	—	—	—		
29. 20B	803	784	809		
30. 25B	846	851	—		
31. Staging Height (ft)	.4	.4	0		
32. Staging Air P (iwg)	—	—	—		
33. Staging Air T (°F)	—	—	—		
34. Stack T (°F)	693	743	712		
35. Fuel Oil T (°F)	—	—	—		
36. Stack Damper (% open)	~100	~100	~100		
37. Bottom Furnace P (iwg)	-.25	-.47	-.65		
38. Convective P (iwg)	.02	.01	-.02		
39. Stack P (iwg)	.07	.12	~0		
40. Air Registers (% open)	10	10	10		
41. Crude API Gravity	22.3	22.3	22.3		
42. Flame Observations					
43. Other Observations					

UNIT OPERATING DATA

Test No. 10/25-1-5 Date 10/25/82 Location SITE 2 Engr. BENSON

Unit No. 11H13 Fuel Absorber Gas RATED Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

Test Description: LOW LOAD TESTING (REGS 50% OPEN BASELINE CAPS ON) (REGS 50% OPEN 4" PORTS) (REG 50% OPEN 4" PORTS LEA) (REGS 33% OPEN 4" PORTS ~4% O_2) (REGS 33% OPEN 4" PORTS ~2% O_2)

1. Test Number	10/25-1	10/25-2	10/25-3	10/25-4	10/25-5
2. Date	10/25/82	→			
3. Time	0920	1040	1120	1230	1315
4. Load x 10^6 Btu/hr	33.2	28.8	→		
5. Process Rate x 1847.7 bbl/d	4.3/7950	→			
6. Crude T_{in} (°F)	360	360	360	370	375
7. Crude T_{out} (°F) East	646	642	648	645	648
8. Crude T_{out} (°F) West	642	649	645	644	644
9. Crude P_{in} (psig) East	100	82	87	88	88
. Crude P_{in} (psig) West	108	90	80	80	80
11. Crude P_{out} (psig)	~24	~21	~21	~22	21.5
12. Reabsorber gas in x 205.856 (10^3 scf/d)	3.0/617.57	2.6/535.22	→		
13. Natural gas in x 169.044 (10^3 scf/d)	0/				
14. Fuel oil in (P) psig	—	—	—	—	—
15. GAS Fuel P/steam P (psig)	7.0	6.0	5.5	5.5	5.5
16. Burner #1	4.8	4.0	3.5	3.5	3.5
17. Burner #2	6.0	5.0	4.6	5.0	4.5
18. Burner #3	6.8	6.0	5.5	5.8	5.6
19. Burner #4	8.2	6.6	6.2	6.4	6.3
20. Burner #5	6.0	5.0	4.6	4.8	4.4
21. Burner #6	5.5	5.6	5.2	5.4	5.2

Oil Flow (bbl/d)

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UNIT OPERATING DATA - CONTINUED

Test No. 10/25-1-5 Date 10/25/82 Location SITE 2 Engr. BENSON

.it No. 11H13 Fuel Absorber GAS Capacity 14 K bbl/day

Unit Type CRUDE HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

Test Description: LOW LOAD TESTING

	(BASELINE REGS 50% OPEN CAPS ON) 10/25-1	(REGS 50% OPEN 4" PORTS) 10/25-2	(REGS 50% OPEN 4" PORTS, LEA) 10/25-3	(REGS 33% OPEN 4" PORTS, ~4% O_2) 10/25-4	(REGS 33% OPEN 4" PORTS ~2% O_2) 10/25-5
22. Tube Skin Temperatures (°F)					
23. 13A	710	710	714	718	725
24. 15A	668	707	710	710	713
25. 20A	708	717	716	717	719
26. 25A	736	745	752	754	760
27. 13B	701	694	700	695	691
28. 15B	674	696	—	—	688
29. 20B	713	718	727	724	726
30. 25B	740	743	763	757	773
31. Staging Height (ft)	—	—	—	—	—
32. Staging Air P (iwg)	—	—	—	—	—
33. Staging Air T (°F)	—	—	—	—	—
34. Stack T (°F)	689	636	602	609	593
35. Fuel Oil T (°F)	—	—	—	—	—
36. Stack Damper (% open)	~100	90	85	90	85
37. Bottom Furnace P (iwg)	-.36	-.08	-.04	-.10	-.08
38. Convective P (iwg)	.01	~.01	~.01	.07	.04
39. Stack P (iwg)	.16	~0	.10	.13	.20
40. Air Registers (% open)	50	50	50	33	33
41. Crude API Gravity	21.6	21.6	21.6	21.6	21.6
42. Flame Observations	LONG BLUE FLAMES	—	—	—	FLAME DARK YELLOW LITTLE SMOKY
43. Other Observations %O_2 BOTTOM HTR/TOP HTR/STACK	13.5/10.8/8.8	—/7.6/5.6	—	6.7/5.9/4.1	4.4/3.8/2.0

UNIT OPERATING DATA

Test No. 10/25-6-10 Date 10/25/82 Location SITE 2 Engr. BENSON

Unit No. 11H13 Fuel Absorber Gas RATED Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

Test Description: (REG 33% OPEN 4" PORTS ~6% O_2) (REGS 10% OPEN 4" PORTS ~4% O_2) (REG 10% OPEN 4" PORTS ~2% O_2) (REGS 10% OPEN 4" PORTS ~6% O_2) (REGS 10% OPEN PORTS CLOSED)

1. Test Number	10/25-6	10/25-7	10/25-8	10/25-9	10/25-10
2. Date	10/25/82	→	→	→	→
3. Time	1420	1520	1600	1710	1820
4. Load x 10^6 Btu/hr	28.8	→	→	→	→
5. Process Rate x 1847.7 bbl/d	4.3/7950	→	→	→	→
6. Crude T_{in} (°F)	365	375	375	370	380
7. Crude T_{out} (°F) East	644	643	639	645	645
8. Crude T_{out} (°F) West	647	651	649	647	650
9. Crude P_{in} (psig) East	83	85	85	83	83
. Crude P_{in} (psig) West	90	90	90	88	88
11. Crude P_{out} (psig)	21	22	21	20	21
12. Reabsorber gas in x 205.856 (10^3 scf/d)	2.6/535.2	→	→	→	→
13. Natural gas in x 169.044 (10^3 scf/d)	0/	→	→	→	→
14. Fuel oil in (P) psig	—	—	—	—	—
15. Gas Fuel P/steam P (psig)	6.0	5.5	5.5	5.8	5.5
16. Burner #1	4.0	3.5	3.5	4.0	3.5
17. Burner #2	5.0	4.6	4.4	5.0	4.6
18. Burner #3	6.2	5.6	5.4	6.0	5.6
19. Burner #4	6.8	6.4	6.2	6.6	6.4
20. Burner #5	5.0	4.6	4.4	5.0	4.6
21. Burner #6	5.8	5.4	5.1	5.0	5.2

Oil Flow (bbl/d)

UNIT OPERATING DATA - CONTINUED

Test No. 10/25-6-10 Date 10/25/82 Location SITE 2 Engr. BENSON

unit No. 11 H13 Fuel Absorber GAS Capacity 14 K bbl/day

Unit Type CRUDE HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

Test Description: LOW LOAD TESTS

	REGS 33% OPEN 4" PORTS, ~6% O_2 10/25-6	REGS 10% OPEN 4" PORTS, ~4% O_2 10/25-7	REGS 10% OPEN 4" PORTS, ~2% O_2 10/25-8	REGS 10% OPEN 4" PORTS ~6% O_2 10/25-9	REG 10% OPEN PORTS CLOSED 10/25-10
22. Tube Skin Temperatures (°F)					
23. 13A	716	728	729	725	717
24. 15A	701	708	710	702	696
25. 20A	717	730	736	725	724
26. 25A	758	771	769	762	755
27. 13B	695	705	705	706	700
28. 15B	698	701	—	—	—
29. 20B	724	731	723	731	727
30. 25B	762	768	768	765	759
31. Staging Height (ft)	—	—	—	—	—
32. Staging Air P (iwg)	—	—	—	—	—
33. Staging Air T (°F)	—	—	—	—	—
34. Stack T (°F)	650	613	590	632	616
35. Fuel Oil T (°F)	—	—	—	—	—
36. Stack Damper (% open)	—	~35	~80	~90	~90
37. Bottom Furnace P (iwg)	-.16	-.14	-.12	-.18	-.24
38. Convective P (iwg)	.3	.38	.05	.02	.05
39. Stack P (iwg)	.09	.28	.42	.32	.04
40. Air Registers (% open)	33	10	10	10	10/30
41. Crude API Gravity	21.6	21.6	21.6	21.6	21.6
42. Flame Observations		BURNER #3 UNSTABLE FLAME	BURNER #3 VERY ERRATIC FLAME LUMINOUS		
43. Other Observations % O_2 BOTTOM / TOP HTR / STACK	10.5/8.4/7.2	8.6/5.8/4.5	5.6/4.3/2.5	10.3/6.5/6.0	

UNIT OPERATING DATA

Test No. 10/26-1-7 Date 10/26/82 Location SITE 2 Engr. BENSON

Unit No. 11H13 Fuel PLANT GAS RATED Capacity 14K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

Test Description: AS FOUND

1. Test Number	10/26-1	10/26-2	10/26-5	10/26-6	10/26-7
2. Date	10/26/82	→	→	→	→
3. Time	0930	1224	1320	1410	1520
4. Load x 10^6 Btu/hr	43.8	→	→	→	→
5. Process Rate x 1847.7 bbl/d	6.2/11455	→	→	→	→
6. Crude T_{in} (°F)	330	335	→	→	→
7. Crude T_{out} (°F) East	654	647	642	663	652
8. Crude T_{out} (°F) West	651	655	656	650	643
9. Crude P_{in} (psig) East	138	110	→	→	→
. Crude P_{in} (psig) West	145	118	→	→	→
11. Crude P_{out} (psig)	30	28	28.5	29	27.5
Reabsorber gas in 12. x 205.856 (10^3 scf/d)	0/0	→	→	→	→
~~Natural gas~~ in PLANT FUEL GAS 13. x 169.044 (10^3 scf/d)	4.6/777.6	5.0/845.2	4.8/811.4	4.8-4.9/819.9	4.9/828.3
14. Fuel oil in (P) psig	—	—	—	—	—
15. Gas Fuel P/steam P (psig)	16	17	15.5	16.3	16.0
16. Burner #1	14.0	→	→	→	→
17. Burner #2	14.6	15.6	14.4	14.9	15.2
18. Burner #3	15.6	16.6	15.2	15.6	15.8
19. Burner #4	16.2	17.0	15.8	16.4	16.6
20. Burner #5	14.8	15.6	14.4	15.0	15.4
21. Burner #6	15.4	15.8	14.8	15.4	15.8

Oil Flow (bbl/d)

Page 2

UNIT OPERATING DATA - CONTINUED

Test No. 10/26-1-7 Date 10/26/82 Location SITE 2 Engr. BENSON

Unit No. 11H13 Fuel PLANT GAS RATED Capacity 14K bbl/day

Unit Type CRUDE HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

Test Description:	(AS FOUND CAPS ON) 10/26-1	(STAGED, 4" PORTS, CO LIMITS) 10/26-2	(STAGED 4" PORTS) 10/26-5	(STAGED 4" PORTS) 10/26-6	(STAGED 4" PORTS) 10/26-7
22. Tube Skin Temperatures (°F)					
23. 13A	783	—	788	—	780
24. 15A	756	—	759	—	749
25. 20A	796	—	809	—	792
26. 25A	832	—	866	—	835
27. 13B	779	—	800	—	782
28. 15B	768	—	785	—	—
29. 20B	814	—	835	—	806
30. 25B	841	—	894	—	851
31. Staging Height (ft)	—	.4	.4	.4	.4
32. Staging Air P (iwg)	—	—	—	—	—
33. Staging Air T (°F)	—	—	—	—	—
34. Stack T (°F)	705	739	694	720	745
35. Fuel Oil T (°F)	—	—	—	—	—
36. Stack Damper (% open)	~100	—	-95	~100	~100
37. Bottom Furnace P (iwg)	-.33 to -.38	—	-.30	-.38	-.50
38. Convective P (iwg)	.01	—	.17	.02	.21
39. Stack P (iwg)	0	—	.14	.06	.11
40. Air Registers (% open)	~50	~50	~10	~10	~10
41. Crude API Gravity	21.6	21.6	21.6	21.6	21.6
42. Flame Observations	—	—	—	—	—
43. Other Observations	—	—	—	—	—

UNIT OPERATING DATA

Test No. 10/26-1R Date 10/26/82 Location SITE 2 Engr. BENSON

Unit No. 11 H13 Fuel FUEL GAS RATED Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

Test Description:

1. Test Number	10/26-1R				
2. Date	10/26/82				
3. Time	1605				
4. Load x 10^6 Btu/hr	36.1				
5. Process Rate x 1847.7 bbl/d	6.2/11455				
6. Crude T_{in} (°F)	345				
7. Crude T_{out} (°F) East	649				
8. Crude T_{out} (°F) West	641				
9. Crude P_{in} (psig) East	110				
. Crude P_{in} (psig) West	118				
11. Crude P_{out} (psig)	26.5				
12. Reabsorber gas in x 205.856 (10^3 scf/d)	0/				
13. Natural gas in x 169.044 (10^3 scf/d)	4.7/794.5				
14. Fuel oil in (P) psig	—				
15. Gas Fuel P/steam P (psig)	14.5				
16. Burner #1	13.0				
17. Burner #2	13.8				
18. Burner #3	14.8				
19. Burner #4	15.4				
20. Burner #5	13.8				
21. Burner #6	14.4				

Oil Flow (bbl/d)

UNIT OPERATING DATA - CONTINUED

Test No. 10/26-1R Date 10/26/82 Location SITE 2 Engr. BENSON

Unit No. 11H13 Fuel FUEL GAS Capacity 14 K bbl/day

Unit Type CRUDE HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

Test Description: (AS FOUND CAPS ON)

	10/26-1R				
22. Tube Skin Temperatures (°F)					
23. 13A	765				
24. 15A	748				
25. 20A	775				
26. 25A	810				
27. 13B	765				
28. 15B	—				
29. 20B	792				
30. 25B	828				
31. Staging Height (ft)	—				
32. Staging Air P (iwg)	—				
33. Staging Air T (°F)	—				
34. Stack T (°F)	713				
35. Fuel Oil T (°F)	—				
36. Stack Damper (% open)	~100				
37. Bottom Furnace P (iwg)	+.03 to -.02				
38. Convective P (iwg)	.64				
39. Stack P (iwg)	.34				
40. Air Registers (% open)	50				
41. Crude API Gravity	21.6				
42. Flame Observations	—				
43. Other Observations	—				

UNIT OPERATING DATA

Test No. 10/27-1-5 Date 10/27/82 Location SITE 2 Engr. BENSON

Unit No. 11 H13 Fuel Adsorber Gas/FUEL GAS RATED Capacity 14K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

Test Description: (BASELINE AS FOUND) (REGS 50% OPEN ~4% O2) (REGS 0% OPEN ~2% O2) (REGS 50% OPEN ~6% O2) (REGS 33% OPEN ~4% O2)

1. Test Number	10/27-1	10/27-2	10/27-3	10/27-4	10/27-5
2. Date	10/27/82	→	→	→	→
3. Time	0950	1100	1150	1240	1415
4. Load x 10^6 Btu/hr	53.5	→	→	→	52.4
5. Process Rate x 1847.7 bbl/d	6.9/12750	→	→	→	→
6. Crude T_{in} (°F)	340	325	→	→	→
7. Crude T_{out} (°F) East	654	647	654	646	646
8. Crude T_{out} (°F) West	642	638	633	652	644
9. Crude P_{in} (psig) East	105	105	107	108	140
. Crude P_{in} (psig) West	112	110	115	115	145
11. Crude P_{out} (psig)	26	26	27	27	31
12. Reabsorber gas in x 205.856 (10^3 scf/d)	3.8/782.26	→	→	→	3.7/761.66
13. Natural gas in x 169.044 (10^3 scf/d)	1.5/253.57	→	→	→	→
14. Fuel oil in (P) psig	—	—	—	—	—
15. GAS Fuel P/steam P (psig)	18	17.5	17.7	18.0	18.0
16. Burner #1	15.5	15.0	16.0	16.0	16.0
17. Burner #2	16.7	16.2-16.8	17.6	17.2	17.0
18. Burner #3	17.4	17.2	17.8	17.6	17.4
19. Burner #4	18.0	17.2-17.8	19.0	18.8	18.4
20. Burner #5	16.6	16.0-16.4	17.4	17.0	17.0
21. Burner #6	17.1	17.0	18.0	17.6	17.0

Oil Flow (bbl/d)

UNIT OPERATING DATA - CONTINUED

Test No. 10/27-1-5 Date 10/27/82 Location SITE 2 Engr. BENSON

Unit No. 11H13 Fuel Adsorber/FUEL GAS RATED Capacity 14 K bbl/day

Unit Type CRUDE HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

Test Description:	(BASELINE AS FOUND) 10/27-1	(REGS 50% OPEN ~4% O₂) 10/27-2	(REG 50% OPEN ~2% O₂) 10/27-3	(REG 50% OPEN ~6% O₂) 10/27-4	(REGS 33% OPEN ~4% O₂) 10/27-5
22. Tube Skin Temperatures (°F)					
23. 13A	759	771	773	–	809
24. 15A	730	745	741	–	781
25. 20A	781	796	796	–	827
26. 25A	832	854	854	–	861
27. 13B	776	774	772	–	813
28. 15B	–	768	–	–	–
29. 20B	816	813	821	–	823
30. 25B	–	882	895	–	863
31. Staging Height (ft)	–	.4	.4	.4	.4
32. Staging Air P (iwg)	–	–	–	–	–
33. Staging Air T (°F)	–	–	–	–	–
34. Stack T (°F)	737	735	719	–	738
35. Fuel Oil T (°F)	–	–	–	–	–
36. Stack Damper (% open)	~100	~100	~100	~100	~100
37. Bottom Furnace P (iwg)	–.45	–.22	–.14	–.28	–.05
38. Convective P (iwg)	.17	.01	.12	.01	0
39. Stack P (iwg)	.33	.03	1.9	.05	–
40. Air Registers (% open)	50	50	50	50	33
41. Crude API Gravity	19.2	19.2	19.2	19.2	19.2
42. Flame Observations				BLUE, DISOTTE FLAMES	YELLOW DIOTTE FLAMES
% O₂ BOTTOM HTR / TOP HTR / STACK 43. Other Observations			6.6 – 7.2 / 4.4 / 1.5		

UNIT OPERATING DATA

Test No. 10/27-6-10 Date 10/27/82 Location SITE 2 Engr. BENSON

Unit No. 11 H13 Fuel Absorber Gas/nat Gas RATED Capacity 14 K bbl/day

Unit Type Crude Heater Burner Type ZINK DBA-22 NATURAL DRAFT.

Test Description:	(REGS 33% OPEN ~2% O_2)	(REGS 33% OPEN ~MAX O_2)	(REGS 10% OPEN ~2% O_2)	(REGS 10% OPEN ~4% O_2)	(REGS 10% OPEN MAX O_2)
1. Test Number	10/27-6	10/27-7	10/27-8	10/27-9	10/27-10
2. Date	10/27/82	→	→	→	→
3. Time	1500	1530	1610	1645	1735
4. Load x 10^6 Btu/hr	50.8	→	→	→	52.4
5. Process Rate x 1847.7 bbl/d	6.9/12750	→	→	→	→
6. Crude T_{in} (°F)	325	→	→	→	→
7. Crude T_{out} (°F) East	642	642	642	646	646
8. Crude T_{out} (°F) West	638	→	→	→	641
9. Crude P_{in} (psig) East	138	138	140	138	140
. Crude P_{in} (psig) West	145	→	→	→	148
11. Crude P_{out} (psig)	30.5	31	31	29	30
12. Reabsorber gas in x 205.856 (10^3 scf/d)	3.7/761.66	→	→	→	→
13. Natural gas in x 169.044 (10^3 scf/d)	1.3/219.72	→	→	→	1.5/253.57
14. Fuel oil in (P) psig	—	—	—	—	—
15. GAS Fuel P/steam P (psig)	17.5	17.5	17.0	18.0	19.5
16. Burner #1	15.0	15.0	15.5	16.0	17.0
17. Burner #2	16.2	16.2	16.8	17.2	18.0
18. Burner #3	17.2	17.2	17.6	18.4	19.2
19. Burner #4	17.8	17.8	18.2	18.7	20.0
20. Burner #5	16.4	16.4	16.6	17.4	18.4
21. Burner #6	16.8	16.8	16.8	18.0	18.8

Oil Flow (bbl/d)

UNIT OPERATING DATA - CONTINUED

Test No. 10/27-6-10 Date 10/27/82 Location SITE 2 Engr. BENSON

Unit No. 11 H13 Fuel Absorber/FUEL GAS RATED Capacity 14K bbl/day

Unit Type CRUDE HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

Test Description:	(REG 33% OPEN ~2% O_2) 10-27-6	(REG 33% OPEN MAX O_2) 10-27-7	(REG 10% OPEN ~2% O_2) 10-27-9	(REG 10% OPEN ~4% O_2) 10-27-8	(REG 10% OPEN MAX O_2) 10-27-10
22. Tube Skin Temperatures (°F)					
23. 13A	818	—	796	790	787
24. 15A	782	—	771	764	763
25. 20A	827	—	827	813	814
26. 25A	838	—	887	869	861
27. 13B	813	—	809	806	801
28. 15B	—	—	—	—	—
29. 20B	826	—	837	825	816
30. 25B	863	—	908	886	871
31. Staging Height (ft)	.4	.4	.4	.4	.4
32. Staging Air P (iwg)	—	—	—	—	—
33. Staging Air T (°F)	—	—	—	—	—
34. Stack T (°F)	722	—	717	746	768
35. Fuel Oil T (°F)	—	—	—	—	—
36. Stack Damper (% open)	~100	~100	~100	~100	100 (MAXED OUT)
37. Bottom Furnace P (iwg)	-.23	-.35	-.35	-.43	-.55
38. Convective P (iwg)	.03	—	.08	~0	~0
39. Stack P (iwg)	.02	—	.51	.04	.06
40. Air Registers (% open)	33	33	10	10	10
41. Crude API Gravity	19.2	19.2	19.2	19.2	19.2
42. Flame Observations	Good FLAME, INTENSITY	BURNER 3, VERY UNSTABLE RICH FLAME	BURNER 3, VERY UNSTABLE, RICH FLAME	—	BLUE FLAME UP TWO FEET FROM BURNER TIPS, THEN YELLOW
43. Other Observations % O_2 BOTTOM HTR/TOP HTR/STACK	8.0/3.9/2.3	—	7.6-8.6/4.1/2.3	9.5 - 10.5/6.1/4.0	11.0/7.6/5.6

UNIT OPERATING DATA

Test No. 10/27-11 Date 10/27/82 Location SITE 2 Engr. BENSON

Unit No. 11 H13 Fuel Adsorber/Fuel Gas RATED Capacity 14 k bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

Test Description: (BASELINE CAPS ON)

1. Test Number	10/27-11				
2. Date	10/27/82				
3. Time	1800				
4. Load x 10^6 Btu/hr	—				
5. Process Rate x 1847.7 bbl/d	6.9/12750				
6. Crude T_{in} (°F)	325				
7. Crude T_{out} (°F) East	642				
8. Crude T_{out} (°F) West	645				
9. Crude P_{in} (psig) East	140				
. Crude P_{in} (psig) West	145				
11. Crude P_{out} (psig)	30				
12. Reabsorber gas in x 205.856 (10^3 scf/d)	3.6/741.08				
13. Natural gas in x 169.044 (10^3 scf/d)	1.5/253.57				
14. Fuel oil in (P) psig	—				
15. GAS Fuel P/steam P (psig)	17.5				
16. Burner #1	16.0				
17. Burner #2	16.6				
18. Burner #3	17.4				
19. Burner #4	18.2				
20. Burner #5	17.0				
21. Burner #6	17.4				

Oil Flow (bbl/d)

SLIP DIP IN
Re gas @1800

UNIT OPERATING DATA - CONTINUED

Test No. 10/27-11 Date 10/27/82 Location SITE 2 Engr. BENSON

Unit No. 11H13 Fuel Adsorber/FUEL GAS RATED Capacity 14K bbl/day

Unit Type CRUDE HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

Test Description: (BASELINE) (CAPS ON)

22. Tube Skin Temperatures (°F)	10/27-11				
23. 13A	796				
24. 15A	770				
25. 20A	808				
26. 25A	864				
27. 13B	785				
28. 15B	—				
29. 20B	817				
30. 25B	877				
31. Staging Height (ft)					
32. Staging Air P (iwg)					
33. Staging Air T (°F)					
34. Stack T (°F)					
35. Fuel Oil T (°F)					
36. Stack Damper (% open)	~100				
37. Bottom Furnace P (iwg)	-.42				
38. Convective P (iwg)	0				
39. Stack P (iwg)	.01				
40. Air Registers (% open)	50				
41. Crude API Gravity	19.2				
42. Flame Observations					
%O_2 BOTTOM HTR / TOP HTR / STACK 43. Other Observations	8.6/4.5?/1.9				

GAS ANALYSIS REPORT

LABORATORY Gas Lab		OPERATOR			DATE October 7, 1982	
UNIT	ABS. GAS TO 11H13					
SAMPLE DATE	10-7-82					
SAMPLE TIME	$10^{\underline{00}}$ A.M.					
PERCENT	Gas Vol.					
HYDROGEN 13	13.5					
NITROGEN 9	1.2					
OXYGEN						
CARBON MONOXIDE 17	1.4					
CARBON DIOXIDE 21						
HYDROGEN SULFIDE 25						
METHANE 29	47.0					
ETHANE 33	18.0					
ETHYLENE 37	8.7					
PROPANE 41	2.8					
PROPYLENE 45	4.5					
ISOBUTANE 49	0.7					
NORMAL BUTANE 53	0.5					
TOTAL BUTENES 57	0.8					
1, 3-BUTADIENE 61						
ISOPENTANE 65	0.2					
NORMAL PENTANE 69	0.1					
TOTAL PENTENES 73						
TOTAL C_6 PLUS 77	0.6					

DIST	REMARKS	PREPARED BY
		SUBMITTED BY

GAS ANALYSIS REPORT

LABORATORY Gas Lab

OPERATOR J. Satcher

DATE October 15, 1982

UNIT Fuel Gas	No. 1 Fuel Gas Drum	Abs. Gas to 11H13				
SAMPLE DATE	10-15-82	—				
SAMPLE TIME	2^{00} P.M.	—				
PERCENT	Gas Vol.	—				
HYDROGEN 13	12.8	13.0				
NITROGEN 9	2.1	1.5				
OXYGEN	0.2	0.1				
CARBON MONOXIDE 17	0.8	1.0				
CARBON DIOXIDE 21	1.7					
HYDROGEN SULFIDE 25	0.1					
METHANE 29	55.3	44.4				
ETHANE 33	16.4	17.3				
ETHYLENE 37	6.5	7.5				
PROPANE 41	1.0	4.7				
PROPYLENE 45	0.9	5.8				
ISOBUTANE 49	0.2	0.6				
NORMAL BUTANE 53	0.4	0.6				
TOTAL BUTENES 57	0.3	1.2				
1, 3-BUTADIENE 61						
ISOPENTANE 65	0.2	0.4				
NORMAL PENTANE 69	0.2	0.2				
TOTAL PENTENES 73						
TOTAL C_6 PLUS 77	0.8	1.6				

DIST. KVB

REMARKS

PREPARED BY

SUBMITTED BY

GAS ANALYSIS REPORT

LABORATORY Gas Lab

OPERATOR J. Satcher

DATE October 21, 1982

UNIT						
Fuel Gas	ABS. GAS TO 11H13					
SAMPLE DATE	10-20-82					
SAMPLE TIME	4^{30} P.M.					
PERCENT	Gas Vol.					
HYDROGEN 13	13.7					
NITROGEN 9	1.7					
OXYGEN	0.1					
CARBON MONOXIDE 17	1.2					
CARBON DIOXIDE 21						
HYDROGEN SULFIDE 25						
METHANE 29	45.3					
ETHANE 33	17.7					
ETHYLENE 37	7.8					
PROPANE 41	4.2					
PROPYLENE 45	5.7					
ISOBUTANE 49	0.2					
NORMAL BUTANE 53	0.3					
TOTAL BUTENES 57	0.6					
1, 3-BUTADIENE 61						
ISOPENTANE 65	0.3					
NORMAL PENTANE 69	0.2					
TOTAL PENTENES 73						
TOTAL C_6 PLUS 77	0.8					

DIST KVB

REMARKS

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GAS ANALYSIS REPORT

LABORATORY: Gas Lab

OPERATOR: J. Satcher

DATE: October 21, 1982

UNIT						
Gas Con.	DeC$_3$ Btms.	DeC$_4$ Btms.	Reabs. Gas			
SAMPLE DATE	10-21-82	—	—			
SAMPLE TIME	8^{00} A.M.	—	—			
PERCENT	Liq. Vol.	—	Gas Vol.			
HYDROGEN 13			13.1			
NITROGEN 9			1.7			
OXYGEN			0.1			
CARBON MONOXIDE 17			1.3			
CARBON DIOXIDE 21			1.8			
HYDROGEN SULFIDE 25						
METHANE 29			46.6			
ETHANE 33			17.6			
ETHYLENE 37			8.0			
PROPANE 41	13.7		3.5			
PROPYLENE 45	9.5		4.7			
ISOBUTANE 49	15.5		0.2			
NORMAL BUTANE 53	18.9		0.1			
TOTAL BUTENES 57	40.4		0.3			
1, 3-BUTADIENE 61	1.2					
ISOPENTANE 65	0.2		0.2			
NORMAL PENTANE 69	0.3		0.1			
TOTAL PENTENES 73						
TOTAL C$_6$ PLUS 77	0.3		0.6			

DIST: GDD (2) JAV
JAK LDW
PJK (3) 7 & I

REMARKS

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GAS ANALYSIS REPORT

LABORATORY Gas Lab

OPERATOR J. Satcher

DATE October 25, 1982

UNIT Absorber	ABS. GAS TO 11H13					
SAMPLE DATE	10-25-82					
SAMPLE TIME	4^{00} P.M.					
PERCENT	Gas Vol.					
HYDROGEN 13	12.0					
NITROGEN 9	1.5					
OXYGEN						
CARBON MONOXIDE 17	1.3					
CARBON DIOXIDE 21	0.1					
HYDROGEN SULFIDE 25						
METHANE 29	44.9					
ETHANE 33	17.3					
ETHYLENE 37	8.0					
PROPANE 41	4.9					
PROPYLENE 45	7.2					
ISOBUTANE 49	0.3					
NORMAL BUTANE 53	0.3					
TOTAL BUTENES 57	0.7					
1, 3-BUTADIENE 61						
ISOPENTANE 65	0.3					
NORMAL PENTANE 69	0.2					
TOTAL PENTENES 73						
TOTAL C_6 PLUS 77	0.8					

DIST KVB

REMARKS

PREPARED BY Joe Satcher

SUBMITTED BY

81 089 (9-80)

GAS ANALYSIS REPORT

LABORATORY Gas Lab

OPERATOR J. Satcher

DATE October 26, 1982

UNIT Fuel Gas	No. 1 Fuel Gas Drum					
SAMPLE DATE	10-26-82					
SAMPLE TIME	$4^{\underline{15}}$ P.M.					
PERCENT	Gas Vol.					
HYDROGEN 13	11.6					
NITROGEN 9	2.2					
OXYGEN	0.2					
CARBON MONOXIDE 17	1.2					
CARBON DIOXIDE 21	2.0					
HYDROGEN SULFIDE 25						
METHANE 29	55.3					
ETHANE 33	16.9					
ETHYLENE 37	7.3					
PROPANE 41	1.0					
PROPYLENE 45	1.2					
ISOBUTANE 49	0.1					
NORMAL BUTANE 53	0.2					
TOTAL BUTENES 57	0.2					
1, 3-BUTADIENE 61						
ISOPENTANE 65	0.1					
NORMAL PENTANE 69	0.1					
TOTAL PENTENES 73						
TOTAL C_6 PLUS 77	0.3					

DIST KVB

REMARKS

PREPARED BY

SUBMITTED BY

81 089 (9 80)

GAS ANALYSIS REPORT

LABORATORY Gas Lab

OPERATOR J. Satcher

DATE October 27, 1982

UNIT Fuel Gas	ABS GAS TO 11H13	NO. 1 FUEL GAS DRUM.				
SAMPLE DATE	10-27-82	—				
SAMPLE TIME	400 P.M.	—				
PERCENT	Gas Vol.	—				
HYDROGEN 13	14.1	13.3				
NITROGEN 9	1.4	1.5				
OXYGEN						
CARBON MONOXIDE 17	1.2	0.9				
CARBON DIOXIDE 21		1.7				
HYDROGEN SULFIDE 25						
METHANE 29	45.6	50.8				
ETHANE 33	18.1	15.9				
ETHYLENE 37	8.0	6.5				
PROPANE 41	3.7	3.1				
PROPYLENE 45	5.4	2.9				
ISOBUTANE 49	0.3	0.7				
NORMAL BUTANE 53	0.3	0.8				
TOTAL BUTENES 57	0.8	0.8				
1, 3-BUTADIENE 61						
ISOPENTANE 65	0.3	0.3				
NORMAL PENTANE 69	0.2	0.2				
TOTAL PENTENES 73						
TOTAL C_6 PLUS 77	0.7	0.6				

DIST KVB

REMARKS

PREPARED BY

SUBMITTED BY

81 089 (9-80)

DATA SET 2

FEBRUARY 8 - JUNE 10, 1983

MOBILE LABORATORY DATA

Test No. 2/8-1

Test No. 2/8-1 Date 2/8/83 Location SITE 2 Engr. BENSON

Unit No. 11H13 Fuel 80% oil 20% Gas RATED Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

1. Test No.	2/8-1									
2. Date	2/8/83									
3. Time	1049-1648									
4. Load 10^6 BTU/HR	37.3									
5. Process Rate bbl/day	11456									
6. Flue Diam. or Size, ft	4.2									
7. Probe Position	STACK									
8. Oxygen (%)	3.6									
9. NOx (hot) read/3% O_2 (ppm)*	–	–								
10. NO (hot) read/3% O_2 (ppm)*	–	–								
11. NO_2 (hot) read/3% O_2 (ppm)*	–	–								
12. NO (cold) read/3% O_2 (ppm)*	263	272								
13. Carbon Dioxide (%)	13.0									
14. Carbon Monoxide (ppm) uncor/cor*	5	5								
15. Hydrocarbon (ppm) uncor/cor*	–	–								
16. Sulfur Dioxide (ppm) uncor/cor*	–	–								
17. Smoke Spot (Bacharach)	–									
18. Atmos. Temp. (°F/°C)	–									
19. Dew Point Temp. (°F/°C)	–									
20. Atmos. Pressure (in. Hg)	–									
21. Relative Humidity (%)	–									
22.										
23.										
24.										
25.										
26.										
27.										
28.										
29.										
30.										

*Correction to 3% O_2 should not be performed if the value is measured on a wet basis.

Data Sheet 6002-2

MOBILE LABORATORY DATA

Test No. 2/9-1

Test No. 2/9-1-2 Date 2/9/83 Location SITE 2 Engr. BESON

Unit No. 11H13 Fuel 80% OIL 20% GAS RATED Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

1. Test No.	2/9-1		2/9-2							
2. Date	2/9/83		2/9/83							
3. Time	1123-1158		1227-1253							
4. Load 10^6 BTU/HR	37.3		37.3							
5. Process Rate bbl/day	11456		11456							
6. Flue Diam. or Size, ft	4.2		4.2							
7. Probe Position	STACK		STACK							
8. Oxygen (%)	4.1		4.1							
9. NOx (hot) read/3% O_2 (ppm)*	—	—	—	—						
10. NO (hot) read/3% O_2 (ppm)*	—	—	—	—						
11. NO_2 (hot) read/3% O_2 (ppm)*	—	—	—	—						
12. NO (cold) read/3% O_2 (ppm)*	272	290	259	276						
13. Carbon Dioxide (%)	12.0		12.5							
14. Carbon Monoxide (ppm) uncor/cor*	6	6	4	4						
15. Hydrocarbon (ppm) uncor/cor*	—	—	—	—						
16. Sulfur Dioxide (ppm) uncor/cor*	—	—	—	—						
17. Smoke Spot (Bacharach)	—		—							
18. Atmos. Temp. (°F/°C)	—		—							
19. Dew Point Temp. (°F/°C)	—		—							
20. Atmos. Pressure (in. Hg)	—		—							
21. Relative Humidity (%)	—		—							
22.										
23.										
24.										
25.										
26.										
27.										
28.										
29.										
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*Correction to 3% O_2 should not be performed if the value is measured on a wet basis.

Data Sheet 6002-2

MOBILE LABORATORY DATA

Test No. 2/10-1-5

Test No. 2/10-1-5 Date 2/10/83 Location SITE 2 Engr. BENSON

Unit No. 11 H13 Fuel 80% OIL 20% GAS RATED Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATUARL DRAFT

1. Test No.	2/10-1		2/10-2		2/10-3		2/10-4		2/10-5	
2. Date	2/10/83		→							
3. Time	1151-1229		1305-1343		1420-1457		1513-1606		1645-1702	
4. Load 10⁶ BTU/HR	32.1		→							
5. Process Rate bbl/day	7945		→							
6. Flue Diam. or Size, ft	4.2		→							
7. Probe Position	STACK		→							
8. Oxygen (%)	4.2		1.8		3.8		2.2		4.1	
9. NOx (hot) read/3% O_2 (ppm)*	–	–	–	–	–	–	–	–	–	–
10. NO (hot) read/3% O_2 (ppm)*	–	–	–	–	–	–	–	–	–	–
11. NO_2 (hot) read/3% O_2 (ppm)*	–	–	–	–	–	–	–	–	–	–
12. NO (cold) read/3% O_2 (ppm)*	313	335	251	235	195	204	125	106	308	328
13. Carbon Dioxide (%)	13.1		14.7		13.2		14.0		13.4	
14. Carbon Monoxide (ppm) uncor/cor*	4	4	9	8	8	8	43	41	5	5
15. Hydrocarbon (ppm) uncor/cor*	–	–	–	–	–	–	–	–	–	–
16. Sulfur Dioxide (ppm) uncor/cor*	–	–	–	–	–	–	–	–	–	–
17. Smoke Spot (Bacharach)	–		–		–		–		–	
18. Atmos. Temp. (°F/°C)	–		–		–		–		–	
19. Dew Point Temp. (°F/°C)	–		–		–		–		–	
20. Atmos. Pressure (in. Hg)	–		–		–		–		–	
21. Relative Humidity (%)	–		–		–		–		–	
22.										
23.										
24.										
25.										
26.										
27.										
28.										
29.										
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*Correction to 3% O_2 should not be performed if the value is measured on a wet basis.

Data Sheet 6002-2

MOBILE LABORATORY DATA

Test No. 2/11-1-5

Test No. 2/11-1-5 Date 2/11/83 Location SITE 2 Engr. BENSON

Unit No. 11 H 13 Fuel 80% OIL 20% GAS RATED Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

1. Test No.	2/11-1		2/11-2		2/11-3		2/11-4		2/11-5	
2. Date	2/11/83		→		→		→		→	
3. Time	0801-0852		1003-1031		1050-1119		1141-1159		1225-1249	
4. Load 10⁶ BTU/HR	44.6		→		→		39.1		39.1	
5. Process Rate bbl/day	13850		→		→		→		→	
6. Flue Diam. or Size, ft	4.2		→		→		→		→	
7. Probe Position	STACK		→		→		→		→	
8. Oxygen (%)	4.5		1.8		4.0		2.0		4.0	
9. NOx (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
10. NO (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
11. NO_2 (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
12. NO (cold) read/3% O_2 (ppm)*	298	325	227	213	213	225	145	137	306	324
13. Carbon Dioxide (%)	12.8		14.9		12.6		15.6		12.3	
14. Carbon Monoxide (ppm) uncor/cor*	7	7	35	33	10	10	43	41	13	14
15. Hydrocarbon (ppm) uncor/cor*	—	—	—	—	—	—	—	—	—	—
16. Sulfur Dioxide (ppm) uncor/cor*	—	—	—	—	—	—	—	—	—	—
17. Smoke Spot (Bacharach)	—		—		—		—		—	
18. Atmos. Temp. (°F/°C)	—		—		—		—		—	
19. Dew Point Temp. (°F/°C)	—		—		—		—		—	
20. Atmos. Pressure (in. Hg)	—		—		—		—		—	
21. Relative Humidity (%)	—		—		—		—		—	
22.										
23.										
24.										
25.										
26.										
27.										
28.										
29.										
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*Correction to 3% O_2 should not be performed if the value is measured on a wet basis.

Data Sheet 6002-2

MOBILE LABORATORY DATA Test No. 2/14-1-5

Test No. 2/14-1-5 Date 2/14/83 Location SITE 2 Engr. BENSON

Unit No. 11 H13 Fuel 80% OIL 20% Gas RATED Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

1. Test No.	2/14-1		2/14-2		2/14-3		2/14-4		2/14-5	
2. Date	2/14/83		→		→		→		→	
3. Time	1147-1323		1408-1446		1518-1609		1641-1703		1750-1808	
4. Load 10^6 BTU/HR	36.5		→		→		→		→	
5. Process Rate bbl/day	11456		→		→		→		→	
6. Flue Diam. or Size, ft	4.2		→		→		→		→	
7. Probe Position	STACK		↔		↔		↔		↔	
8. Oxygen (%)	3.7		3.8		3.8		4.1		3.9	
9. NOx (hot) read/3% O_2 (ppm)*	–	–	–	–	–	–	–	–	–	–
10. NO (hot) read/3% O_2 (ppm)*	–	–	–	–	–	–	–	–	–	–
11. NO_2 (hot) read/3% O_2 (ppm)*	–	–	–	–	–	–	–	–	–	–
12. NO (cold) read/3% O_2 (ppm)*	260	271	209	219	189	198	188	200	247	260
13. Carbon Dioxide (%)	12.7		13.3		13.7		13.3		13.6	
14. Carbon Monoxide (ppm) uncor/cor*	15	15	16	16	18	18	29	29	10	10
15. Hydrocarbon (ppm) uncor/cor*	–	–	–	–	–	–	–	–	–	–
16. Sulfur Dioxide (ppm) uncor/cor*	–	–	–	–	–	–	–	–	–	–
17. Smoke Spot (Bacharach)	–		–		–		–		–	
18. Atmos. Temp. (°F/°C)	–		–		–		–		–	
19. Dew Point Temp. (°F/°C)	–		–		–		–		–	
20. Atmos. Pressure (in. Hg)	–		–		–		–		–	
21. Relative Humidity (%)	–		–		–		–		–	
22.										
23.										
24.										
25.										
26.										
27.										
28.										
29.										
30.										

*Correction to 3% O_2 should not be performed if the value is measured on a wet basis.

Data Sheet 6002-2

MOBILE LABORATORY DATA

Test No. 2/15-1-5

Test No. 2/15-1-5 Date 2/15/83 Location SITE 2 Engr. BENSON

Unit No. 11H13 Fuel 80% OIL 20% GAS RATED Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

1. Test No.	2/15-1		2/15-2		2/15-3		2/15-4		2/15-5	
2. Date	2/15/83		→		→		→		→	
3. Time	0859-0936		1005-1044		1107-1146		1216-1255		1315-1343	
4. Load 10^6 BTU/HR.	39.4		→		→		43.4		43.4	
5. Process Rate bbl/day	11456		→		→		→		→	
6. Flue Diam. or Size, ft	4.2		→		→		→		→	
7. Probe Position	STACK		→		→		→		→	
8. Oxygen (%)	3.8		→		→		3.9		3.9	
9. NOx (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
10. NO (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
11. NO_2 (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
12. NO (cold) read/3% O_2 (ppm)*	290	304	272	285	264	276	225	237	257	271
13. Carbon Dioxide (%)	13.2		13.2		13.3		13.1		13.5	
14. Carbon Monoxide (ppm) uncor/cor*	13	14	8	8	10	10	11	11	12	13
15. Hydrocarbon (ppm) uncor/cor*	—	—	—	—	—	—	—	—	—	—
16. Sulfur Dioxide (ppm) uncor/cor*	—	—	—	—	—	—	—	—	—	—
17. Smoke Spot (Bacharach)	—		—		—		—		—	
18. Atmos. Temp. (°F/°C)	—		—		—		—		—	
19. Dew Point Temp. (°F/°C)	—		—		—		—		—	
20. Atmos. Pressure (in. Hg)	—		—		—		—		—	
21. Relative Humidity (%)	—		—		—		—		—	
22.										
23.										
24.										
25.										
26.										
27.										
28.										
29.										
30.										

*Correction to 3% O_2 should not be performed if the value is measured on a wet basis.

Data Sheet 6002-2

MOBILE LABORATORY DATA

Test No. 2/15-6-8

Test No. 2/15-6-8 Date 2/15/83 Location SITE 2 Engr. BENSON

Unit No. 11 H13 Fuel 80% OIL 20% GAS RATED Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

1. Test No.	2/15-6		2/15-7		2/15-8					
2. Date	2/15/83		—		→					
3. Time	1404-1440		1507-1530		1554-1622					
4. Load	38.4		—		→					
5. Process Rate	11456		—		→					
6. Flue Diam. or Size, ft	4.2		—		→					
7. Probe Position	STACK		—		→					
8. Oxygen (%)	3.8		4.0		3.9					
9. NOx (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—				
10. NO (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—				
11. NO_2 (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—				
12. NO (cold) read/3% O_2 (ppm)*	289	302	291	308	282	297				
13. Carbon Dioxide (%)	13.2		12.2		13.0					
14. Carbon Monoxide (ppm) uncor/cor*	7	7	9	9	21	22				
15. Hydrocarbon (ppm) uncor/cor*	—	—	—	—	—	—				
16. Sulfur Dioxide (ppm) uncor/cor*	—	—	—	—	—	—				
17. Smoke Spot (Bacharach)	—		—		—					
18. Atmos. Temp. (°F/°C)	—		—		—					
19. Dew Point Temp. (°F/°C)	—		—		—					
20. Atmos. Pressure (in. Hg)	—		—		—					
21. Relative Humidity (%)	—		—		—					
22.										
23.										
24.										
25.										
26.										
27.										
28.										
29.										
30.										

*Correction to 3% O_2 should not be performed if the value is measured on a wet basis.

Data Sheet 6002-2

Test No. 2/16-1-5

MOBILE LABORATORY DATA

Test No. 2/16-1-5 Date 2/16/83 Location SITE 2 Engr. BENSON

Unit No. 11 H13 Fuel NOMINAL 80% OIL 20% GAS RATED Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

1. Test No.	2/16-1		2/16-2		2/16-3		2/16-4		2/16-5	
2. Date	2/16/83		—		—		—		→	
3. Time	0833-0858		1142-1218		1315-1343		1410-1426		1521-1538	
4. Load 10⁶ BTU/HR	46.5		49.7		50.8		48.9		52.3	
5. Process Rate bbl/day	11456		11511		11511		11530		11511	
6. Flue Diam. or Size, ft	4.2		—		—		—		→	
7. Probe Position	STACK		—		—		—		→	
8. Oxygen (%)	4.1		4.1		4.2		5.4		3.9	
9. NOx (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
10. NO (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
11. NO_2 (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
12. NO (cold) read/3% O_2 (ppm)*	283	301	241	257	224	240	233	269	293	308
13. Carbon Dioxide (%)	12.2		12.8		13.1		11.9		12.8	
14. Carbon Monoxide (ppm) uncor/cor*	3	3	10	11	12	13	10	12	4	4
15. Hydrocarbon (ppm) uncor/cor*	—	—	—	—	—	—	—	—	—	—
16. Sulfur Dioxide (ppm) uncor/cor*	—	—	—	—	—	—	—	—	—	—
17. Smoke Spot (Bacharach)	—		—		—		—		—	
18. Atmos. Temp. (°F/°C)	—		—		—		—		—	
19. Dew Point Temp. (°F/°C)	—		—		—		—		—	
20. Atmos. Pressure (in. Hg)	—		—		—		—		—	
21. Relative Humidity (%)	—		—		—		—		—	
22.										
23.										
24.										
25.										
26.										
27.										
28.										
29.										
30.										

*Correction to 3% O_2 should not be performed if the value is measured on a wet basis.

Data Sheet 6002-2

MOBILE LABORATORY DATA

Test No. 2/17-1-5

Test No. 2/17-1-5 Date 2/17/83 Location SITE 2 Engr. BENSON

Unit No. 11H13 Fuel 80% OIL 20% GAS RATED Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

1. Test No.	2/17-1		2/17-2		2/17-3		2/17-4		2/17-5	
2. Date	2/17/83		—		—		—		→	
3. Time	0803-0859		0900-0934		0948-1023		1042-1110		1124-1141	
4. Load 10^6 BTU/HR	46.4		—		—		—		→	
5. Process Rate bbl/day	11493		—		—		—		→	
6. Flue Diam. or Size, ft	4.2		—		—		—		→	
7. Probe Position	STACK		—		—		—		→	
8. Oxygen (%)	5.7		5.7		5.8		5.8		5.9	
9. NOx (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
10. NO (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
11. NO_2 (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
12. NO (cold) read/3% O_2 (ppm)*	292	344	268	324	266	315	238	282	291	347
13. Carbon Dioxide (%)	11.6		11.7		11.8		11.7		11.3	
14. Carbon Monoxide (ppm) uncor/cor*	4	5	3	4	3	4	7	8	5	6
15. Hydrocarbon (ppm) uncor/cor*	—	—	—	—	—	—	—	—	—	—
16. Sulfur Dioxide (ppm) uncor/cor*	—	—	—	—	—	—	—	—	—	—
17. Smoke Spot (Bacharach)	—		—		—		—		—	
18. Atmos. Temp. (°F/°C)	—		—		—		—		—	
19. Dew Point Temp. (°F/°C)	—		—		—		—		—	
20. Atmos. Pressure (in. Hg)	—		—		—		—		—	
21. Relative Humidity (%)	—		—		—		—		—	
22.										
23.										
24.										
25.										
26.										
27.										
28.										
29.										
30.										

*Correction to 3% O_2 should not be performed if the value is measured on a wet basis.

Data Sheet 6002-2

MOBILE LABORATORY DATA

Test No. 2/22-1-5

Test No. 2/22-1-5 Date 2/22/83 Location SITE 2 Engr. BENSON

Unit No. 11 H13 Fuel 80% OIL 20% GAS RATED Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

1. Test No.	2/22-1		2/22-2		2/22-3		2/22-4		2/22-5	
2. Date	2/22/83		→							
3. Time	1419-1454		1520-1537		1549-1606		1625-1642		1656-1709	
4. Load 106 BTU/HR	51.4		49.3		49.3		47.3		47.3	
5. Process Rate bbl/day	11456		→							
6. Flue Diam. or Size, ft	4.2		→							
7. Probe Position	STACK		→							
8. Oxygen (%)	6.1		6.0		4.9		3.9		2.9	
9. NOx (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
10. NO (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
11. NO_2 (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
12. NO (cold) read/3% O_2 (ppm)*	286	345	276	331	274	306	226	277	220	219
13. Carbon Dioxide (%)	11.8		11.7		12.4		13.0		13.7	
14. Carbon Monoxide (ppm) uncor/cor*	2	3	4	5	5	6	6	5	9	9
15. Hydrocarbon (ppm) uncor/cor*	—	—	—	—	—	—	—	—	—	—
16. Sulfur Dioxide (ppm) uncor/cor*	—	—	—	—	—	—	—	—	—	—
17. Smoke Spot (Bacharach)	—		—		—		—		—	
18. Atmos. Temp. (°F/°C)	—		—		—		—		—	
19. Dew Point Temp. (°F/°C)	—		—		—		—		—	
20. Atmos. Pressure (in. Hg)	—		—		—		—		—	
21. Relative Humidity (%)	—		—		—		—		—	
22.										
23.										
24.										
25.										
26.										
27.										
28.										
29.										
30.										

*Correction to 3% O_2 should not be performed if the value is measured on a wet basis.

Data Sheet 6002-2

MOBILE LABORATORY DATA

Test No. 2/22-6-7

Test No. 2/22-6-7 Date 2/22/83 Location SITE 2 Engr. BENSON

Unit No. 11H13 Fuel 80% OIL 20% GAS RATED Capacity 14 K bbl /day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

1. Test No.	2/22-6		2/22-7							
2. Date	2/22/83		2/22/83							
3. Time	1729-1738		1759-1816							
4. Load 10⁶ BTU /HR	46.5		46.5							
5. Process Rate bbl /day	11456		11456							
6. Flue Diam. or Size, ft	4.2		4.2							
7. Probe Position	STACK		STACK							
8. Oxygen (%)	2.1		5.8							
9. NOx (hot) read/3% O_2 (ppm)*	—	—	—	—						
10. NO (hot) read/3% O_2 (ppm)*	—	—	—	—						
11. NO_2 (hot) read/3% O_2 (ppm)*	—	—	—	—						
12. NO (cold) read/3% O_2 (ppm)*	182	173	305	361						
13. Carbon Dioxide (%)	13.7		13.6							
14. Carbon Monoxide (ppm) uncor/cor*	29	28	5	6						
15. Hydrocarbon (ppm) uncor/cor*	—	—	—	—						
16. Sulfur Dioxide (ppm) uncor/cor*	—	—	—	—						
17. Smoke Spot (Bacharach)	—		—							
18. Atmos. Temp. (°F/°C)	—		—							
19. Dew Point Temp. (°F/°C)	—		—							
20. Atmos. Pressure (in. Hg)	—		—							
21. Relative Humidity (%)	—		—							
22.										
23.										
24.										
25.										
26.										
27.										
28.										
29.										
30.										

*Correction to 3% O_2 should not be performed if the value is measured on a wet basis.

Data Sheet 6002-2

MOBILE LABORATORY DATA

Test No. 2/23-1-4

Test No. 2/23-1-4 Date 2/23/83 Location SITE 2 Engr. BENSON

Unit No. 11 H13 Fuel 80% OIL 20% GAS RATED Capacity 14 K bbl /day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

1. Test No.	2/23-1		2/23-2		2/23-3		2/23-4		2/23-4R	
2. Date	2/23/83		—		—		—		→	
3. Time	1026-1042		1102-1119		1143-1208		1223-1314		1612-1647	
4. Load 10⁶ BTU/HR	46.1		—		—		—		→	
5. Process Rate bbl/day	11456		—		—		—		→	
6. Flue Diam. or Size, ft	4.2		—		—		—		→	
7. Probe Position	STACK		—		—		—		→	
8. Oxygen (%)	5.7		6.0		4.8		4.1		4.1	
9. NOx (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
10. NO (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
11. NO_2 (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
12. NO (cold) read/3% O_2 (ppm)*	293	345	227	318	259	288	239	267	310	330
13. Carbon Dioxide (%)	11.4		11.6		12.3		13.2		13.0	
14. Carbon Monoxide (ppm) uncor/cor*	5	6	5	6	8	7	12	13	4	4
15. Hydrocarbon (ppm) uncor/cor*	—	—	—	—	—	—	—	—	—	—
16. Sulfur Dioxide (ppm) uncor/cor*	—	—	—	—	—	—	—	—	—	—
17. Smoke Spot (Bacharach)	—		—		—		—		—	
18. Atmos. Temp. (°F/°C)	—		—		—		—		—	
19. Dew Point Temp. (°F/°C)	—		—		—		—		—	
20. Atmos. Pressure (in. Hg)	—		—		—		—		—	
21. Relative Humidity (%)	—		—		—		—		—	
22.										
23.										
24.										
25.										
26.										
27.										
28.										
29.										
30.										

*Correction to 3% O_2 should not be performed if the value is measured on a wet basis.

Data Sheet 6002-2

MOBILE LABORATORY DATA

Test No. 2/23-5-8

Test No. 2/23-5-8 Date 2/23/83 Location SITE 2 Engr. BENSON

Unit No. 11H13 Fuel 80% OIL 20% GAS RATED Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

1. Test No.	2/23-5		2/23-6		2/23-7		2/23-8			
2. Date	2/23/83		→							
3. Time	1648-1706		1715-1724		1725-1733		1756-1808			
4. Load 10^6 BTU/HR	36.5		→							
5. Process Rate bbl/day	11456		→							
6. Flue Diam. or Size, ft	4.2		→							
7. Probe Position	STACK		→							
8. Oxygen (%)	3.0		4.2		5.4		5.7			
9. NOx (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—		
10. NO (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—		
11. NO_2 (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—		
12. NO (cold) read/3% O_2 (ppm)*	271	271	245	263	262	302	297	349		
13. Carbon Dioxide (%)	14.1		13.0		12.2		11.6			
14. Carbon Monoxide (ppm) uncor/cor*	17	17	5	5	2	2	2	2		
15. Hydrocarbon (ppm) uncor/cor*	—	—	—	—	—	—	—	—		
16. Sulfur Dioxide (ppm) uncor/cor*	—	—	—	—	—	—	—	—		
17. Smoke Spot (Bacharach)	—		—		—		—			
18. Atmos. Temp. (°F/°C)	—		—		—		—			
19. Dew Point Temp. (°F/°C)	—		—		—		—			
20. Atmos. Pressure (in. Hg)	—		—		—		—			
21. Relative Humidity (%)	—		—		—		—			
22.										
23.										
24.										
25.										
26.										
27.										
28.										
29.										
30.										

*Correction to 3% O_2 should not be performed if the value is measured on a wet basis.

Data Sheet 6002-2

MOBILE LABORATORY DATA

Test No. 2/24-1-5

Test No. 2/24-1-5 Date 2/24/83 Location SITE 2 Engr. BENSON

Unit No. 11H13 Fuel 80% OIL 20% GAS RATED Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

1. Test No.	2/24-1		2/24-2		2/24-3		2/24-4		2/24-5	
2. Date	2/24/83		→							
3. Time	1249-1446		1543-1606		1642-1701		1702-1719		1810-1828	
4. Load 10⁶ BTU/HR	32.1		→							
5. Process Rate bbl/day	11511		→							
6. Flue Diam. or Size, ft	4.2		→							
7. Probe Position	STACK		→							
8. Oxygen (%)	5.8		6.1		5.1		4.9		5.9	
9. NOx (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
10. NO (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
11. NO_2 (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
12. NO (cold) read/3% O_2 (ppm)*	319	378	233	281	204	231	201	225	340	380
13. Carbon Dioxide (%)	12.6		11.6		13.0		12.9		12.1	
14. Carbon Monoxide (ppm) uncor/cor*	2	3	7	8	10	11	11	12	5	6
15. Hydrocarbon (ppm) uncor/cor*	—	—	—	—	—	—	—	—	—	—
16. Sulfur Dioxide (ppm) uncor/cor*	—	—	—	—	—	—	—	—	—	—
17. Smoke Spot (Bacharach)	—		—		—		—		—	
18. Atmos. Temp. (°F/°C)	—		—		—		—		—	
19. Dew Point Temp. (°F/°C)	—		—		—		—		—	
20. Atmos. Pressure (in. Hg)	—		—		—		—		—	
21. Relative Humidity (%)	—		—		—		—		—	
22.										
23.										
24.										
25.										
26.										
27.										
28.										
29.										
30.										

*Correction to 3% O_2 should not be performed if the value is measured on a wet basis.

Data Sheet 6002-2

MOBILE LABORATORY DATA   Test No. 2/25-1-5

Test No. 2/25-1-5 Date 2/25/83 Location SITE 2 Engr. BENSON

Unit No. 11 H13 Fuel 80% OIL 20% GAS RATED Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

1. Test No.	2/25-1		2/25-2		2/25-3		2/25-4		2/25-5	
2. Date	2/25/83		→							
3. Time	0939-0956		← →							
4. Load 10⁶ BTU/HR	25.3		→							
5. Process Rate bbl/day	7945		→							
6. Flue Diam. or Size, ft	4.2		→							
7. Probe Position	STACK		→							
8. Oxygen (%)	5.8		5.7		5.8		6.1		5.9	
9. NOx (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
10. NO (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
11. NO_2 (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
12. NO (cold) read/3% O_2 (ppm)*	341	404	287	338	277	328	233	281	318	379
13. Carbon Dioxide (%)	12.2		12.7		12.2		11.9		11.9	
14. Carbon Monoxide (ppm) uncor/cor*	5	6	4	5	8	9	13	16	5	6
15. Hydrocarbon (ppm) uncor/cor*	—	—	—	—	—	—	—	—	—	—
16. Sulfur Dioxide (ppm) uncor/cor*	—	—	—	—	—	—	—	—	—	—
17. Smoke Spot (Bacharach)	—		—		—		—		—	
18. Atmos. Temp. (°F/°C)	—		—		—		—		—	
19. Dew Point Temp. (°F/°C)	—		—		—		—		—	
20. Atmos. Pressure (in. Hg)	—		—		—		—		—	
21. Relative Humidity (%)	—		—		—		—		—	
22.										
23.										
24.										
25.										
26.										
27.										
28.										
29.										
30.										

*Correction to 3% O_2 should not be performed if the value is measured on a wet basis.

Data Sheet 6002-2

MOBILE LABORATORY DATA

Test No. 2/28-1-5

Test No. 2/28-1-5 Date 2/28/83 Location SITE 2 Engr. BENSON

Unit No. 11 H13 Fuel 80% OIL 20% GAS RATED Capacity 14K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

1. Test No.	2/28-1		2/28-2		2/28-3		2/28-4		2/28-5	
2. Date	2/28/83		2/28/83		2/28/83		2/28/83		2/28/83	
3. Time	1020-1055		1126-1143		1254-1316		1354-1410		1427-1445	
4. Load 10⁶ BTU/HR	42.8		42.8		37.0		→			
5. Process Rate bbl/day	14000		→							
6. Flue Diam. or Size, ft	4.2		→							
7. Probe Position	STACK		→							
8. Oxygen (%)	4.3		4.3		4.2		4.1		4.6	
9. NOx (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
10. NO (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
11. NO_2 (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—	—	—
12. NO (cold) read/3% O_2 (ppm)*	289	312	267	288	240	257	208	222	284	308
13. Carbon Dioxide (%)	13.1		12.3		12.6		12.9		12.6	
14. Carbon Monoxide (ppm) uncor/cor*	6	7	6	7	10	11	16	17	6	7
15. Hydrocarbon (ppm) uncor/cor*	—	—	—	—	—	—	—	—	—	—
16. Sulfur Dioxide (ppm) uncor/cor*	—	—	—	—	—	—	—	—	—	—
17. Smoke Spot (Bacharach)	—		—		—		—		—	
18. Atmos. Temp. (°F/°C)	—		—		—		—		—	
19. Dew Point Temp. (°F/°C)	—		—		—		—		—	
20. Atmos. Pressure (in. Hg)	—		—		—		—		—	
21. Relative Humidity (%)	—		—		—		—		—	
22.										
23.										
24.										
25.										
26.										
27.										
28.										
29.										
30.										

*Correction to 3% O_2 should not be performed if the value is measured on a wet basis.

Data Sheet 6002-2

MOBILE LABORATORY DATA

Test No. 3/2-3/4

Test No. 3/2 - 3/4 Date 3/2/83 Location SITE 2 Engr. BENSON

Unit No. 11H13 Fuel 80% OIL 20% GAS RATED Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

1. Test No.	3/2-1		3/3-1		3/3-1		3/4-1			
2. Date	3/2/83		3/3/83		3/3/83		3/4/83			
3. Time	0901-1855		0832-1037		1403-1606		0825-1100			
4. Load 10⁶ BTU/HR	40.4		40.4		40.4		38.9			
5. Process Rate bbl/	11460		11455		11455		11640			
6. Flue Diam. or Size, ft	4.2		→		→		→			
7. Probe Position	STACK		→		→		→			
8. Oxygen (%)	5.9		5.8		6.0		6.1			
9. NOx (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—		
10. NO (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—		
11. NO_2 (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—		
12. NO (cold) read/3% O_2 (ppm)*	301	359	296	351	294	353	309	374		
13. Carbon Dioxide (%)	12.6		12.3		13.0		10.7			
14. Carbon Monoxide (ppm) uncor/cor*	6	8	4	5	3	4	7	8		
15. Hydrocarbon (ppm) uncor/cor*	—	—	—	—	—	—	—	—		
16. Sulfur Dioxide (ppm) uncor/cor*	—	—	—	—	—	—	420	350		
17. Smoke Spot (Bacharach)	1.5-3		—		—		—			
18. Atmos. Temp. (°F/°C)	63/17 **		—		—		—			
19. Dew Point Temp. (°F/°C)	—		—		—		—			
20. Atmos. Pressure (in. Hg)	29.40 **		—		—		—			
21. Relative Humidity (%)	50 **		—		—		—			
22.										
23.										
24.										
25.										
26.										
27.										
28.										
29.										
30.										

*Correction to 3% O_2 should not be performed if the value is measured on a wet basis.

Data Sheet 6002-2

* READINGS TAKEN AT 1600

MOBILE LABORATORY DATA

Test No. 6/8 - 6/9

Test No. 6/8 - 6/9 Date 6/8 - 6/9/83 Location SITE 2 Engr. BENSON

Unit No. 11H13 Fuel 70% OIL - 30% GAS RATED Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

1. Test No.	6/8-1		6/9-1		6/9-2		6/9-3			
2. Date	6/8/83		6/9/83							
3. Time	1510-1653		0720-0819		1139-1520		1536-1708			
4. Load 10^6 BTU/HR	53.4		46.2		45.7					
5. Process Rate bbl/day	11640									
6. Flue Diam. or Size, ft	4.2									
7. Probe Position	STACK									
8. Oxygen (%)	3.3		3.4		2.2		2.1			
9. NOx (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—		
10. NO (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—		
11. NO_2 (hot) read/3% O_2 (ppm)*	—	—	—	—	—	—	—	—		
12. NO (cold) read/3% O_2 (ppm)*		235		246		165		145		
13. Carbon Dioxide (%)	14.3		13.5		13.4		13.9			
14. Carbon Monoxide (ppm) uncor/cor*		5		8		15		4		
15. Hydrocarbon (ppm) uncor/cor*	—	—	—	—	—	—	—	—		
16. Sulfur Dioxide (ppm) uncor/cor*		318	—	—	—	—	307	307		
17. Smoke Spot (Bacharach)	—		—		—		—			
18. Atmos. Temp. (°F/°C)	—		—		—		—			
19. Dew Point Temp. (°F/°C)	—		—		—		—			
20. Atmos. Pressure (in. Hg)	—		—		—		—			
21. Relative Humidity (%)	—		—		—		—			
22.										
23.										
24.										
25.										
26.										
27.										
28.										
29.										
30.										

*Correction to 3% O_2 should not be performed if the value is measured on a wet basis.

Data Sheet 6002-2

MOBILE LABORATORY DATA

Test No. 6/10-1-2

Test No. 6/10-1-2 Date 6/10/83 Location SITE 2 Engr. BENSON

Unit No. 11H13 Fuel 65% OIL 35% GAS RATED Capacity 14 K bbl/day

Unit Type PROCESS HEATER Burner Type ZINK DBA-22 NATURAL DRAFT

1. Test No.	6/10-1		6/10-2				
2. Date	6/10/83		6/10/83				
3. Time	0704-0803		1156-1506				
4. Load 10⁶ BTU/HR	50.9		48.5				
5. Process Rate bbl/day	11455		11455				
6. Flue Diam. or Size, ft	4.2		4.2				
7. Probe Position	STACK		STACK				
8. Oxygen (%)	3.3		2.5				
9. NOx (hot) read/3% O_2 (ppm)*	—	—	—	—			
10. NO (hot) read/3% O_2 (ppm)*	—	—	—	—			
11. NO_2 (hot) read/3% O_2 (ppm)*	—	—	—	—			
12. NO (cold) read/3% O_2 (ppm)*	248	252	193	168			
13. Carbon Dioxide (%)	11.4		12.3				
14. Carbon Monoxide (ppm) uncor/cor*	5	5	9	9			
15. Hydrocarbon (ppm) uncor/cor*	—	—	—	—			
16. Sulfur Dioxide (ppm) uncor/cor*	—	—	345	336			
17. Smoke Spot (Bacharach)	—		—				
18. Atmos. Temp. (°F/°C)	—		—				
19. Dew Point Temp. (°F/°C)	—		—				
20. Atmos. Pressure (in. Hg)	—		—				
21. Relative Humidity (%)	—		—				
22.							
23.							
24.							
25.							
26.							
27.							
28.							
29.							
30.							

*Correction to 3% O_2 should not be performed if the value is measured on a wet basis.

Data Sheet 6002-2

UNIT OPERATING DATA

Test No. 2/8-1 Date 2/8/83 Location Site #2 Engr. Benson

Unit No. 11 H13 Fuel 80% Oil/20% Gas Rated Capacity 14K BBL/D

Unit Type Refinery Process Heater Burner Type DBA-22 Oil/Gas

Test Description: BaseLine BaseLine BaseLine BaseLine

1. Test Number	2/8-1	2/8-1	2/8-1	2/8-1	
2. Date	2/8/83	2/8/83	2/8/83	2/8/83	
3. Time	1120	1305	1430	1615	
4. Load x 10^6 Btu/hr	37.3	37.3	37.3	37.3	
5. Process Rate x 1847.7 bbl/d	6.2/11456	6.2/11456	6.2/11456	6.2/11456	
6. Crude T_{in} (°F)	350	345	345	348	
7. Crude T_{out} (°F) East	654	648	652	650	
8. Crude T_{out} (°F) West	646	640	649	652	
9. Crude P_{in} (psig) East	85	90	90	92	
10. Crude P_{in} (psig) West	90	95	97	98	
11. Crude P_{out} (psig)	23	23	23	24	
12. Reabsorber gas in x 205.856 (10^3 scf/d)	.7/144.1 (10^3)	.7/144.1 (10^3)	.7/144.1 (10^3)	.7/144.1 (10^3)	
13. Natural gas in x 169.044 (10^3 scf/d)	0/0	0/0	0/0	0/0	
14. Fuel oil in (P)/Gas in (P)	58/3.0	57/3.0	57/3.0	57/3.0	
15. Gas Fuel P/~~steam~~ Oil P (psig)/Steam P	—	—	—	—	
16. Burner #1	0/-/84	0/-/84	0/-/84	0/-/84	
17. Burner #2	1.8/68/-	1.6/68/-	1.7/68/	1.6/68/-	
18. Burner #3	3.0/55/78	2.8/55/78	3.0/53/78	3.0/53/78	
19. Burner #4	3.6/52/78	3.4/52/78	3.6/52/78	3.6/52/78	
20. Burner #5	2.0/46/56	1.8/46/56	2.0/46/57	1.8/46/56	
21. Burner #6	3.6/56/74	3.4/56/74	3.6/58/75	3.8/58/74	
Fuel Oil Flow (BBL/D)	115	115	116	115	

UNIT OPERATING DATA - CONTINUED

Test No. 2/8-1 Date 2/8/83 Location Site #2 Engr. Benson

Unit No. 11 H13 Fuel 80% oil/20% Gas Rated Capacity 14K BBL/D

Unit Type Refinery Process Heater Burner Type DBA-22 oil/Gas

Test Description:	BaseLine 2/8-1	BaseLine 2/8-1	BaseLine 2/8-1	BaseLine 2/8-1	
22. Tube Skin Temperatures (°F)					
23. 13A	730	729	735	740	
24. 15A	709	710	709	705	
25. 20A	722	723	726	728	
26. 25A	766	764	766	769	
27. 13B	732	732	737	731	
28. 15B	716	713	712	713	
29. 20B	749	750	748	746	
30. 25B	770	772	767	765	
31. Staging Height (ft)	—	—	—	—	
32. Staging Air P (iwg)	—	—	—	—	
33. Staging Air T (°F)	—	—	—	—	
34. Stack T (°F)	690	689	688	689	
35. Fuel Oil T (°F)	—	—	—	—	
36. Stack Damper (% open)	—	—	—	—	
37. Bottom Furnace P (iwg)	-.38	-.35	-.36	-.38	
38. Convective P (iwg)	+.02	+.02	+.02	+.03	
39. Stack P (iwg)	+.04	+.12	+.09	+.06	
40. Air Registers (% open)	33	33	33	33	
41. Crude API Gravity	21.0	21.0	21.0	21.0	
42. Flame Observations	Burners Smoky				
43. Other Observations	Flame Length ~ 4' above tube skin TC's				

UNIT OPERATING DATA

Test No. 2/9-1 Date 2/9/83 Location Site #2 Engr. Benson

Unit No. 11 H13 Fuel 80% oiL/20% Gas Rated Capacity 14K BBL/D

Unit Type Refinery Process Heater Burner Type DRA-22 OiL/GAS

Test Description: BaseLine BaseLine BaseLine

1. Test Number	2/9-1	2/9-2	2/9-2		
2. Date	2/9/83	2/9/83	2/9/83		
3. Time	1055	1155	1600		
4. Load x 10^6 Btu/hr	37.3	37.3	37.3		
5. Process Rate x 1847.7 bbl/d	6.2/11456	6.2/11456	6.2/11456		
6. Crude T_{in} (°F)	345	345	348		
7. Crude T_{out} (°F) East	645	646	647		
8. Crude T_{out} (°F) West	656	658	660		
9. Crude P_{in} (psig) East	95	95	98		
10. Crude P_{in} (psig) West	100	100	102		
11. Crude P_{out} (psig)	25	25	26		
12. Reabsorber gas in x 205.856 (10^3 scf/d)	.7/144.1 (10^3)	.7/144.1 (10^3)	.7/144.1 (10^3)		
13. Natural gas in x 169.044 (10^3 scf/d)	0/0	0/0	0/0		
14. Fuel oil in (P) psig /Gas in (P)	57/3.0	57/2.5	57/2.5		
15. GAS ↓ Fuel P/~~steam~~ oil P (psig)/Steam P	—	—	—		
16. Burner #1	0/-/-	0/-/-	0/52/80		
17. Burner #2	1.8/-/-	2.0/-/-	2.0/48/80		
18. Burner #3	3.0/-/-	3.2/-/-	3.2/48/80		
19. Burner #4	3.8/-/-	3.8/-/-	4.0/50/80		
20. Burner #5	2.0/-/-	2.0/-/-	2.0/52/78		
21. Burner #6	3.8/-/-	4.0/-/-	4.0/42/78		

Fuel Oil Flow (bbl/d) ← Avg. 112 →

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UNIT OPERATING DATA - CONTINUED

Test No. 2/9-1 Date 2/9/83 Location Site #2 Engr. Benson

Unit No. 11 H13 Fuel 80% oil/20% Gas Rated Capacity 14 K BBL/D

Unit Type Refinery Process Heater Burner Type DBA-22 Oil/GAS

Test Description:

	Baseline 2/9-1	Baseline 2/9-2	Baseline 2/9-2		
22. Tube Skin Temperatures (°F)					
23. 13A	742	735	745		
24. 15A	706	708	721		
25. 20A	729	732	740		
26. 25A	778	775	787		
27. 13B	724	723	732		
28. 15B	703	701	712		
29. 20B	743	741	751		
30. 25B	765	764	779		
31. Staging Height (ft)	—	—	—		
32. Staging Air P (iwg)	—	—	—		
33. Staging Air T (°F)	—	—	—		
34. Stack T (°F)	698	698	695		
35. Fuel Oil T (°F)	—	—	—		
36. Stack Damper (% open)	Opened slightly more than Baseline 2/8	SAME	SAME		
37. Bottom Furnace P (iwg)	-.33	-.34	-.34		
38. Convective P (iwg)	+.08	+.05	+.05		
39. Stack P (iwg)	+.08	+.06	+.07		
40. Air Registers (% open)	33	33	33		
41. Crude API Gravity	21.7	21.7	21.7		
42. Flame Observations	SEE Flame temperature and CO Data Sheets				
43. Other Observations					

UNIT OPERATING DATA

Test No. 2/10-1-5 Date 2/10/83 Location Site #2 Engr. Benson

Unit No. 11H13 Fuel 80% oil/20% Gas Rated Capacity 14K BBL/D

Unit Type Refinery Process Heater Burner Type DBA-22 oil/Gas

Test Description:	Baseline	LEA	SCA	LEA+SCA	Baseline, Repeat
1. Test Number	2/10-1	2/10-2	2/10-3	2/10-4	2/10-5
2. Date	2/10/83	2/10/83	2/10/83	2/10/83	2/10/83
3. Time	1150	1300	1420	1550	1700
4. Load x 10^6 Btu/hr	32.1	32.1	32.1	32.1	32.1
5. Process Rate x 1847.7 bbl/d	4.3/7945	4.3/7945	4.3/7945	4.3/7945	4.3/7945
6. Crude T_{in} (°F)	400	405	400	385	370
7. Crude T_{out} (°F) East	653	655	652	649	648
8. Crude T_{out} (°F) West	656	657	662	665	663
9. Crude P_{in} (psig) East	95	87	100	91	102
10. Crude P_{in} (psig) West	90	92	105	99	110
11. Crude P_{out} (psig)	23	24	26.5	25	25.5
12. Reabsorber gas in x 205.856 (10^3 scf/d)	.7/144.1 (10^3)	.7/144.1 (10^3)	.7/144.1 (10^3)	.7/144.1 (10^3)	.7/144.1 (10^3)
13. Natural gas in x 169.044 (10^3 scf/d)	0/0	0/0	0/0	0/0	0/0
14. Fuel oil in (P) psig/Gas in (P)	56/2.5	54/1.5	56/2.5	56/1.5	54/2.5
15. GAS Fuel P/oil ~~steam~~ P (psig)/Steam P	—	—	—	—	—
16. Burner #1	0/-/-	0/77/50	0/50/78	0/-/-	0/50/76
17. Burner #2	1.0/-/-	1.0/77/47	1.6/47/80	1.2/77/47	1.6/47/78
18. Burner #3	2.4/-/-	2.4/79/47	2.7/46/79	3.0/77/46	2.8/46/78
19. Burner #4	3.0/-/-	3.0/80/49	3.4/49/80	3.0/80/49	3.4/50/76
20. Burner #5	1.2/-/-	1.2/77/49	1.6/50/77	2.2/77/49	1.6/50/76
21. Burner #6	3.2/-/-	3.2/76/41	3.6/42/76	3.4/76/41	3.6/42/76
Fuel Oil Flow (bbl/d)	91	90	89	92	94

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UNIT OPERATING DATA - CONTINUED

Test No. 2/10-1-5 Date 2/10/83 Location Site #2 Engr. Benson

Unit No. 11H13 Fuel 80% Oil/20% Gas Rated Capacity 14K BBL/D

Unit Type Refinery Process Heater Burner Type DBA-22 Oil/GAS

Test Description:	BaseLine 2/10-1	LEA 2/10-2	SCA 2/10-3	LEA+SCA 2/10-4	Baseline Repeat 2/10-5
22. Tube Skin Temperatures (°F)					
23. 13A	724	742	754	764	749
24. 15A	706	719	731	739	726
25. 20A	728	741	752	771	741
26. 25A	757	772	782	807	764
27. 13B	720	733	738	747	729
28. 15B	700	713	715	732	700
29. 20B	737	749	746	749	732
30. 25B	757	770	770	786	752
31. Staging Height (ft)	—	—	.4 ft	.4 ft	—
32. Staging Air P (iwg)	—	—	—	—	—
33. Staging Air T (°F)	—	—	—	—	—
34. Stack T (°F)	681	648	670	639	684
35. Fuel Oil T (°F)	—	—	—	—	—
36. Stack Damper (% open)	Closed Down to 1st notch	Closed Further Down Almost to 2nd notch	Slightly more open than baseline closed down From test # 2	Closed Down 2 notches +	—
37. Bottom Furnace P (iwg)	-.28	-.34	-.15	-.15	-.23
38. Convective P (iwg)	+.02	+.03	+.01	+.02	0.0
39. Stack P (iwg)	+.03	+.03	0.0	+.06	0.0
40. Air Registers (% open)	33	25	25	25	33
41. Crude API Gravity	21.7	21.7	21.7	21.7	21.7
42. Flame Observations	Flames 3' Above Skin TC's	Little Smoky	Flames 4-5' Above skin TC's Orange Flame	Very Smoky in furnace	Good Bright Fire
43. Other Observations					

UNIT OPERATING DATA

Test No. 2/11-1-5 Date 2/11/83 Location Site #2 Engr. Benson

Unit No. 11H13 Fuel 80% Oil/20% Gas Rated Capacity 14K BBL/D

Unit Type Refinery Process Heater Burner Type DBA-22 Oil/Gas

Test Description:	Baseline	LEA	SCA	LEA + SCA	Baseline Repeat
1. Test Number	2/11-1	2/11-2	2/11-3	2/11-4	2/11-5
2. Date	2/11/83	2/11/83	2/11/83	2/11/83	2/11/83
3. Time	0815	1000	1100	1140	1225
4. Load x 10^6 Btu/hr	44.6	44.6	44.6	39.1	39.1
5. Process Rate x 1847.7 bbl/d	7.5/13850	7.5/13850	7.5/13850	7.5/13850	7.5/13850
6. Crude T_{in} (°F)	330	330	330	330	332
7. Crude T_{out} (°F) East	646	658	646	647	641
8. Crude T_{out} (°F) West	654	655	650	652	654
9. Crude P_{in} (psig) East	100	110	90	90	91
10. Crude P_{in} (psig) West	95	107	95	95	99
11. Crude P_{out} (psig)	23	22	21	23	23
12. Reabsorber gas in x 205.856 (10^3 scf/d)	.7/144.1 (10^3)	.7/144.1 (10^3)	.7/144.1 (10^2)	.7/144.1 (10^3)	.7/144.1 (10^3)
13. Natural gas in x 169.044 (10^3 scf/d)	0/0	0/0	0/0	0/0	0/0
14. Fuel oil in (P) psig/Gas in (P)	62/2.5	62/-	62/2.0	62/2.5	62/2.5
15. Gas Fuel P/~~steam~~ Oil P (psig)/steam P	—	—	—	—	—
16. Burner #1	0/58/84	0/57/83	0/58/82	0/57/85	0/57/85
17. Burner #2	1.6/52/84	1.6/51/83	1.6/52/82	1.8/51/83	1.6/51/84
18. Burner #3	2.6/52/85	2.8/51/85	2.8/52/84	2.5/51/85	2.5/52/85
19. Burner #4	3.4/56/86	3.5/58/86	3.4/56/85	3.5/56/87	3.5/56/87
20. Burner #5	1.6/57/84	1.6/57/83	1.6/56/82	1.7/57/83	1.6/57/83
21. Burner #6	3.6/40/82	3.6/41/82	3.4/42/82	3.4/41/82	3.6/41/82
Fuel Oil Flow (bbl/d)	136	141	139	116	121

UNIT OPERATING DATA - CONTINUED

Test No. 2/11-1-5 Date 2/11/83 Location Site #2 Engr. Benson

Unit No. 11 H13 Fuel 80% oiL/20% GAS Rated Capacity 14 K BBL/D

Unit Type Refinery Process Heater Burner Type DBA-22 oiL/GAS

Test Description:	BaseLine 2/11-1	LEA 2/11-2	SCA 2/11-3	LEA+SCA 2/11-4	BaseLine, Repeat 2/11-5
22. Tube Skin Temperatures (°F)					
23. 13A	751	772	762	770	743
24. 15A	713	734	749	763	734
25. 20A	735	756	746	773	731
26. 25A	775	783	781	797	761
27. 13B	728	760	743	754	718
28. 15B	701	727	731	754	696
29. 20B	743	754	752	761	729
30. 25B	762	778	779	792	750
31. Staging Height (ft)	—	—	.4 ft	.4 ft	—
32. Staging Air P (iwg)	—	—	—	—	—
33. Staging Air T (°F)	—	—	—	—	—
34. Stack T (°F)	719	663	689	686	698
35. Fuel Oil T (°F)	—	—	—	—	—
36. Stack Damper (% open)	midway between notch 1 and 2	closed Damper Down further	opened Damper	—	BaseLine
37. Bottom Furnace P (iwg)	-.38	-.36	-.20	-.13	-.27
38. Convective P (iwg)	+.02	+.04	+.05	+.03	+.02
39. Stack P (iwg)	+.06	+.07	+.11	+.09	+.07
40. Air Registers (% open)	50	25	25	25	50
41. Crude API Gravity	21.6	21.6	21.6	21.6	21.6
42. Flame Observations	Flame Length Beyond view	Smoky	Smoky	Very smoky; Flame Length undetectable	Good Fire
43. Other Observations	From viewpoint, clean Fire				

UNIT OPERATING DATA

Test No. 2/14-1-5 **Date** 2/14/83 **Location** Site #2 **Engr.** Benson

Unit No. 11H13 **Fuel** 80% oiL/20% Gas **Rated Capacity** 14K BBL/D

Unit Type Refinery Process Heater **Burner Type** DBA-22 OiL/Gas

Test Description:

	Baseline	4' SCA (FD) med. BER Burner ℄	4' SCA (FD) min. BER Burner ℄	4' SCA (FD) min. BER Heater ℄	Baseline, Repeat
1. Test Number	2/14-1	2/14-2	2/14-3	2/14-4	2/14-5
2. Date	2/14/83	2/14/83	2/14/83	2/14/83	2/14/83
3. Time	1215	1430	1540	1647	1750
4. Load x 10^6 Btu/hr	36.5	36.5	36.5	36.5	36.5
5. Process Rate x 1847.7 bbl/d	6.2/11456	6.2/11456	6.2/11456	6.2/11456	6.2/11456
6. Crude T_{in} (°F)	342	345	345	342	342
7. Crude T_{out} (°F) East	652	655	661	653	656
8. Crude T_{out} (°F) West	651	645	645	649	643
9. Crude P_{in} (psig) East	95	95	95	95	95
10. Crude P_{in} (psig) West	100	100	100	100	101
11. Crude P_{out} (psig)	22.5	23.5	22	22.5	23
12. Reabsorber gas in x 205.856 (10^3 scf/d)	.7/144.1 (10^3)	.7/144.1 (10^3)	.7/144.1 (10^3)	.7/144.1 (10^3)	.7/144.1 (10^3)
13. Natural gas in x 169.044 (10^3 scf/d)	0/0	0/0	0/0	0/0	0/0
14. Fuel oil in (P) psig	63	62	61	61	62
15. Gas Fuel P/~~steam~~ oil P (psig)/Steam P	—	—	—	—	—
16. Burner #1	0/57/85	0/57/84	0/57/84	0/57/84	0/57/84
17. Burner #2	1.7/51/84	1.7/52/84	1.7/52/84	1.7/52/84	1.7/52/84
18. Burner #3	2.6/54/85	2.6/55/86	2.6/55/86	2.6/55/86	2.6/55/86
19. Burner #4	3.6/55/87	3.6/57/87	3.6/57/87	3.6/57/87	3.6/57/87
20. Burner #5	1.8/57/83	1.8/57/84	1.8/57/84	1.8/57/84	1.8/57/84
21. Burner #6	3.6/39/83	3.6/39/82	3.6/39/82	3.6/39/82	3.6/39/82
Fuel Oil Flow (bbl/d)	108	—	104	109	111

UNIT OPERATING DATA - CONTINUED

Test No. 2/14-1-5 Date 2/14/83 Location Site #2 Engr. Benson

Unit No. 11H13 Fuel 80% oil/20% Gas Rated Capacity 14K BBL/D

Unit Type Refinery Process Heater Burner Type DBA-22 Oil/Gas

Test Description:	Baseline 2/14-1	4'SCA(FD) med. Bed Burner & 2/14-2	4'SCA(FD) min.Bed Burner & 2/14-3	4'SCA(FD) min Bed Heater & 2/14-4	Baseline, Repeat 2/14-5
22. Tube Skin Temperatures (°F)					
23. 13A	742	761	784	752	740
24. 15A	714	740	777	733	711
25. 20A	730	750	794	748	734
26. 25A	769	794	824	776	770
27. 13B	735	732	742	727	728
28. 15B	707	713	735	712	695
29. 20B	744	747	766	743	739
30. 25B	765	784	807	769	758
31. Staging Height (ft)	-	4	4	4	-
32. Staging Air P (iwg)	-	1.9	4.2	4.2	-
33. Staging Air T (°F)	-	335	328	328	-
34. Stack T (°F)	708	678	647	682	704
35. Fuel Oil T (°F)	-	-	-	-	-
36. Stack Damper (% open)	-	no change From Baseline	Damper closed Slightly From Baseline	-	-
37. Bottom Furnace P (iwg)	-.38	-.36	-.31	-.23	-.40
38. Convective P (iwg)	+.02	+.01	+.02	+.03	+.03
39. Stack P (iwg)	+.06	+.02	+.05	+.08	+.07
40. Air Registers (% open)	33	25	10	25	33
41. Crude API Gravity	21.0	21.0	21.0	21.0	21.0
42. Flame Observations					
43. Other Observations					

UNIT OPERATING DATA

Test No. 2/15-1-5 Date 2/15/83 Location Site #2 Engr. Benson

Unit No. 11H13 Fuel 80% oil/20% Gas Rated Capacity 14K BBL/D

Unit Type Refinery Process Heater Burner Type DBA-22 Oil/Gas

Test Description:	Baseline	3' SCA (FD) Max. BER	3' SCA (FD) Med. BER	3' SCA (FD) Min. BER	3' SCA (FD) Min. BER
1. Test Number	2/15-1	2/15-2	2/15-3	2/15-4	2/15-5
2. Date	2/15/83	2/15/83	2/15/83	2/15/83	2/15/83
3. Time	0905	1015	1115	1250	1320
4. Load x 10^6 Btu/hr	39.4	39.4	39.4	43.4	43.4
5. Process Rate x 1847.7 bbl/d	6.2/11456	6.2/11456	6.2/11456	6.2/11456	6.2/11456
6. Crude T_{in} (°F)	345	350	350	350	351
7. Crude T_{out} (°F) East	649	648	652	640	641
8. Crude T_{out} (°F) West	651	657	657	666	660
9. Crude P_{in} (psig) East	90	90	90	87	89
10. Crude P_{in} (psig) West	95	95	96	93	95
11. Crude P_{out} (psig)	22.7	23.2	23	23	23.5
12. Reabsorber gas in x 205.856 (10^3 scf/d)	.7/144.1(10^3)	.7/144.1(10^3)	.7/144.1(10^3)	.7/144.1(10^3)	.7/144.1(10^3)
13. Natural gas in x 169.044 (10^3 scf/d)	0/0	0/0	0/0	0/0	0/0
14. Fuel oil in (P) psig	61	61	61	61	61
15. Gas Fuel P/~~steam~~ oil P (psig)/Steam P	–	–	–	–	–
16. Burner #1	0/57/81	0/57/81	0/57/81	0/57/81	0/57/81
17. Burner #2	.8/52/82	1.0/51/83	1.0/51/83	1.0/51/83	1.0/51/83
18. Burner #3	1.8/55/85	2.0/53/85	2.0/53/85	2.0/53/85	1.8/53/85
19. Burner #4	2.6/55/85	2.8/55/86	2.8/55/86	2.8/55/86	2.5/55/86
20. Burner #5	1.0/57/84	1.1/57/83	1.1/57/83	1.1/57/83	0.8/57/83
21. Burner #6	2.7/39/81	3.0/39/82	3.0/39/82	3.0/39/82	2.7/39/82
Fuel Oil Flow (bbl/d)	121	118	118	138	130

UNIT OPERATING DATA - CONTINUED

Test No. 2/15-1-5 Date 2/15/83 Location Site #2 Engr. Benson

Unit No. 11H13 Fuel 80% oil/20% GAS Rated Capacity 14K BBL/D

Unit Type Refinery Process Heater Burner Type DBA-22 Oil/Gas

Test Description:

	Baseline 2/15-1	3'SCA(FD) Max. BER 2/15-2	3'SCA(FD) Med. BER 2/15-3	3'SCA(FD) Min. BER 2/15-4	2'SCA (FD) Min. BER. 2/15-5
22. Tube Skin Temperatures (°F)					
23. 13A	744	746	756	726	723
24. 15A	719	731	745	731	718
25. 20A	737	738	744	739	729
26. 25A	782	782	793	799	774
27. 13B	737	744	743	799	750
28. 15B	712	731	738	806	736
29. 20B	757	767	768	791	752
30. 25B	782	788	790	808	791
31. Staging Height (ft)	—	3	3	3	2
32. Staging Air P (iwg)	—	2.4	2.6	5.9	5.6
33. Staging Air T (°F)	—	418	351	328	328
34. Stack T (°F)	703	702	694	674	690
35. Fuel Oil T (°F)	—	—	—	—	—
36. Stack Damper (% open)	-	no stack Damper change	closed Damper A tad	Damper closed A little more	-
37. Bottom Furnace P (iwg)	-.41	-.40	-.39	-.36	-.28
38. Convective P (iwg)	+.01	+.08	+.06	+.06	+.04
39. Stack P (iwg)	+.03	+.13	+.05	+.05	+.03
40. Air Registers (% open)	33	25	15	10	—
41. Crude API Gravity	21.2	21.2	21.2	21.2	21.2
42. Flame Observations					
43. Other Observations					

UNIT OPERATING DATA

Test No. 2/15-6-8 Date 2/15/83 Location Site #2 Engr. Benson

Unit No. 11H13 Fuel 80% oil/20% Gas Rated Capacity 14K BBL/D

Unit Type Refinery Process Heater Burner Type DBA-22 Oil/Gas

Test Description: 2' SCA (FD) Med. BER | 2' SCA (FD) Max. BER | BaseLine, Repeat

1. Test Number	2/15-6	2/15-7	2/15-8		
2. Date	2/15/83	2/15/83	2/15/83		
3. Time	1428	1455	1550		
4. Load x 10^6 Btu/hr	38.4	38.4	38.4		
5. Process Rate x 1847.7 bbl/d	6.2/11456	6.2/11456	6.2/11456		
6. Crude T_{in} (°F)	341	342	351		
7. Crude T_{out} (°F) East	644	647	643		
8. Crude T_{out} '°F) West	651	657	661		
9. Crude P_{in} (psig) East	89	89	89		
10. Crude P_{in} (psig) West	95	95	95		
11. Crude P_{out} (psig) .	23	22.5	25		
12. Reabsorber gas in x 205.856 (10^3 scf/d)	.7/144.1 (10^3)	.7/144.1 (10^3)	.7/144.1 (10^3)		
13. Natural gas in x 169.044 (10^3 scf/d)	0/0	0/0	0/0		
14. Fuel oil in (P) psig	61	61	61		
15. Gas Fuel P/~~steam~~ oil P (psig)/Steam P	—	—	—		
16. Burner #1	0/57/81	0/57/81	0/57/81		
17. Burner #2	1.0/51/83	1.0/51/83	1.0/51/84		
18. Burner #3	1.8/53/85	1.8/53/85	2.1/55/85		
19. Burner #4	2.5/55/86	2.5/55/86	2.8/56/87		
20. Burner #5	0.8/57/83	0.8/57/83	1.0/57/84		
21. Burner #6	2.7/39/82	2.7/39/82	2.8/39/83		
Fuel Oil Flow (bbl/d)	115	115	115		

UNIT OPERATING DATA - CONTINUED

Test No. 2/15-6-8 Date 2/15/83 Location Site #2 Engr. Benson

Unit No. 11H13 Fuel 80% oil/20% Gas Rated Capacity 14K BBL/D

Unit Type Refinery Process Heater Burner Type DBA-22 Oil/Gas

Test Description:

	2'SCA (FD) Med. BER 2/15-6	2'SCA (FD) Max. BER 2/15-7	Baseline, Repeat 2/15-8		
22. Tube Skin Temperatures (°F)					
23. 13A	742	739	733		
24. 15A	726	722	717		
25. 20A	731	734	732		
26. 25A	779	783	781		
27. 13B	753	753	757		
28. 15B	734	733	729		
29. 20B	759	764	765		
30. 25B	787	789	791		
31. Staging Height (ft)	2	2	—		
32. Staging Air P (iwg)	2.6	1.4	—		
33. Staging Air T (°F)	328	328	—		
34. Stack T (°F)	691	702	698		
35. Fuel Oil T (°F)	—	—	—		
36. Stack Damper (% open)	—	—	—		
37. Bottom Furnace P (iwg)	-.27	-.27	-.36		
38. Convective P (iwg)	+.05	+.03	+.05		
39. Stack P (iwg)	+.03	+.02	+.04		
40. Air Registers (% open)	—	—	—		
41. Crude API Gravity	21.2	21.2	21.2		
42. Flame Observations					
43. Other Observations					

UNIT OPERATING DATA

Test No. 2/16-1-5 Date 2/16/83 Location Site #2 Engr. Benson

Unit No. 11H13 Fuel 80% oil/20% Gas Rated Capacity 14K BBL/D

Unit Type Refinery Process Heater Burner Type DBA-22 Oil/Gas

Test Description:	BaseLine	SCA (FD) Max. BER	SCA (FD) Med. BER	SCA (FD) Min. BER	BaseLine, Repeat
1. Test Number	2/16-1	2/16-2	2/16-3	2/16-4	2/16-5
2. Date	2/16/83	2/16/83	2/16/83	2/16/83	2/16/83
3. Time	0818	1149	1330	1424	1527
4. Load x 10^6 Btu/hr	46.5	49.7	50.8	48.9	52.3
5. Process Rate x 1847.7 bbl/d	6.20/11456	6.23/11511	6.23/11511	6.24/11530	6.23/11511
6. Crude T_{in} (°F)	351	330	325	330	330
7. Crude T_{out} (°F) East	649	655	649	669	652
8. Crude T_{out} (°F) West	657	652	649	636	656
9. Crude P_{in} (psig) East	91	91	95	90	90
10. Crude P_{in} (psig) West	97	96	100	95	95
11. Crude P_{out} (psig)	25	23	23	24	23
12. Reabsorber gas in x 205.856 (10^3 scf/d)	.7/144.1 (10^3)	.7/144.1 (10^3)	.7/144.1 (10^3)	.7/144.1 (10^3)	.7/144.1 (10^3)
13. Natural gas in x 169.044 (10^3 scf/d)	0/0	0/0	0/0	0/0	0/0
14. Fuel oil in (P) psig	62	63	63	62	62
15. GAS Fuel P/~~steam~~ OiL P (psig)/Steam P	—	—	—	—	—
16. Burner #1	0/59/83	0/52/83	0/58/83	0/58/83	0/58/82
17. Burner #2	.2/52/84	1.0/54/84	1.0/52/83	1.2/52/83	.9/52/82
18. Burner #3	1.8/54/85	2.1/56/86	2.2/54/85	2.3/54/85	2.0/54/84
19. Burner #4	2.4/56/86	2.8/57/83	2.9/56/86	3.1/56/86	2.8/56/86
20. Burner #5	.8/57/83	1.2/40/82	1.2/57/84	1.4/57/83	1.0/57/83
21. Burner #6	2.5/40/82	2.9/58/82	3.0/40/82	3.1/40/82	2.8/40/82
FUEL Oil Flow (bbl/d)	145	157	161	154	167

UNIT OPERATING DATA - CONTINUED

Test No. 2/16-1-5 Date 2/16/83 Location Site #2 Engr. Benson

Unit No. 11H13 Fuel 80% oil/20% Gas Rated Capacity 14K BBL/D

Unit Type Refinery Process Heater Burner Type DBA-22 Oil/Gas

Test Description:

	Baseline 2/16-1	8' SCA (FD) Max. BER 2/16-2	8' SCA (FD) Med. BER 2/16-3	8' SCA (FD) Min BER 2/16-4	Baseline, Repeat 2/16-5
22. Tube Skin Temperatures (°F)					
23. 13A	752	768	796	805	741
24. 15A	724	749	781	802	715
25. 20A	740	753	765	801	731
26. 25A	787	811	834	884	775
27. 13B	749	751	759	768	732
28. 15B	727	735	738	740	708
29. 20B	764	780	793	811	758
30. 25B	790	807	825	862	777
31. Staging Height (ft)	—	8	8	8	—
32. Staging Air P (iwg)	—	1.8	3.3	6.0	—
33. Staging Air T (°F)	—	—	—	—	—
34. Stack T (°F)	707	693	676	650	716
35. Fuel Oil T (°F)	—	—	—	—	—
36. Stack Damper (% open)	1/2 notch closed	virtually no change	Little if no change from Baseline	Damper opened from last two conditions	Back to Baseline
37. Bottom Furnace P (iwg)	-.42	-.32	-.38	-.29	-.39
38. Convective P (iwg)	+.06	0	+.01	+.01	+.07
39. Stack P (iwg)	+.07	+.15	+.19	+.15	+.12
40. Air Registers (% open)	33	33	20	33	33
41. Crude API Gravity	21.2	21.2	21.2	21.2	21.2
42. Flame Observations	Yellow/bushy #2 Burner Smoky	#2 and #6 Burner smoky	All Burners Smoky	All Burners Smoky	Yellow
43. Other Observations					

UNIT OPERATING DATA

Test No. 2/17-1-5 Date 2/17/83 Location Site #2 Engr. Benson

Unit No. 11H13 Fuel 80% oil/20% Gas Rated Capacity 14K BBL/D

Unit Type Refinery Process Heater Burner Type DBA-22 Oil/Gas

Test Description:	Baseline	4' SCA (FD) Max. BER	4' SCA (FD) Med. BER	4' SCA (FD) Min. BER	Baseline, Repeat
1. Test Number	2/17-1	2/17-2	2/17-3	2/17-4	2/17-5
2. Date	2/17/83	2/17/83	2/17/83	2/17/83	2/17/83
3. Time	0809	0910	1010	1050	1130
4. Load x 10^6 Btu/hr	46.4	46.4	46.4	46.4	46.4
5. Process Rate x 1847.7 bbl/d	6.22/11493	6.22/11493	6.22/11493	6.22/11493	6.22/11493
6. Crude T_{in} (°F)	350	350	354	355	354
7. Crude T_{out} (°F) East	652	652	652	654	649
8. Crude T_{out} (°F) West	651	656	654	646	649
9. Crude P_{in} (psig) East	90	90	90	90	91
10. Crude P_{in} (psig) West	95	95	95	95	96
11. Crude P_{out} (psig) .	23.0	23.0	23.0	23.0	22.5
12. Reabsorber gas in x 205.856 (10^3 scf/d)	.7/144.1 (10^3)	.7/144.1 (10^3)	.7/144.1 (10^3)	.7/144.1 (10^3)	.7/144.1 (10^3)
13. Natural gas in x 169.044 (10^3 scf/d)	0/0	0/0	0/0	0/0	0/0
14. Fuel oil in (P) psig	62	62	62	62	62
15. Gas Fuel P/~~steam~~ oil P (psig)/Steam P	—	—	—	—	—
16. Burner #1	0/58/84	0/58/83	0/58/82	0/58/83	0/58/84
17. Burner #2	.8/52/84	.7/52/83	.7/52/82	.9/52/83	1.1/52/84
18. Burner #3	2.0/54/85	1.8/54/84	1.9/54/84	2.0/54/85	2.2/54/85
19. Burner #4	2.6/56/86	2.6/58/86	2.6/56/85	2.8/56/86	3.0/56/86
20. Burner #5	1.0/57/84	.8/57/83	.9/57/82	1.0/57/84	1.2/56/84
21. Burner #6	2.8/38/82	2.6/39/82	2.6/40/81	2.8/40/82	3.0/40/82
Fuel Oil Flow (bbl/d)	140	143	140	145	149

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UNIT OPERATING DATA - CONTINUED

Test No. 2/17-1-5 Date 2/17/83 Location Site #2 Engr. Benson

Unit No. 11H13 Fuel 80% oil/20% Gas Rated Capacity 14K BBL/D

Unit Type Refinery Process Heater Burner Type DBA-22 Oil/Gas

Test Description:

	Baseline 2/17-1	4'SCA (FD) Max. BER 2/17-2	4'SCA (FD) Med. BER 2/17-3	4'SCA (FD) Min. BER 2/17-4	Baseline, Repeat 2/17-5
22. Tube Skin Temperatures (°F)					
23. 13A	745	753	751	763	737
24. 15A	722	727	733	753	711
25. 20A	726	729	732	742	721
26. 25A	767	762	769	778	760
27. 13B	722	738	731	730	719
28. 15B	702	718	734	732	697
29. 20B	742	759	783	799	746
30. 25B	764	765	771	772	760
31. Staging Height (ft)	—	4	4	4	—
32. Staging Air P (iwg)	—	1.4	2.7	6.0	—
33. Staging Air T (°F)	—	—	—	—	—
34. Stack T (°F)	745	733	712	698	744
35. Fuel Oil T (°F)	—	—	—	—	—
36. Stack Damper (% open)	Set at top notch open position	No change From Baseline	No change From Baseline	—	—
37. Bottom Furnace P (iwg)	-.29	-.29	-.33	-.30	-.37
38. Convective P (iwg)	+.01	+.14	+.15	+.18	+.08
39. Stack P (iwg)	+.14	+.17	+.18	+.19	+.08
40. Air Registers (% open)	50	40	33	33	50
41. Crude API Gravity	21.0	21.0	21.0	21.0	21.0
42. Flame Observations	Bushy Flames	Burners #1, 3, 5 smoky	All Burners smoky	Smoky	#5 Burner Smoky
43. Other Observations		(Flame Heights	A ~ level of tube skin TC's	#3 Burner small flame	

UNIT OPERATING DATA

Test No. 2/22-1-5 Date 2/22/83 Location Site #2 Engr. Benson

Unit No. 11H13 Fuel 80% oil/20% Gas Rated Capacity 14K BBL/D

Unit Type Refinery Process Heater Burner Type DBA-22 Oil/Gas

Test Description:	Baseline	4' SCA (FD) Max. BER, 6% O_2	4' SCA (FD) Max. BER, 5% O_2	4' SCA (FD) Max. BER, 4% O_2	4' SCA (FD) Max. BER, 3% O_2
1. Test Number	2/22-1	2/22-2	2/22-3	2/22-4	2/22-5
2. Date	2/22/83	2/22/83	2/22/83	2/22/83	2/22/83
3. Time	1430	1525	1555	1640	1700
4. Load x 10^6 Btu/hr	51.4	49.3	49.3	47.3	47.3
5. Process Rate x 1847.7 bbl/d	6.2/11456	6.2/11456	6.2/11456	6.2/11456	6.2/11456
6. Crude T_{in} (°F)	350	355	—	353	353
7. Crude T_{out} (°F) East	651	654	653	657	648
8. Crude T_{out} (°F) West	654	649	651	653	650
9. Crude P_{in} (psig) East	92	92	92	90	90
10. Crude P_{in} (psig) West	98	98	98	95	95
11. Crude P_{out} (psig)	23	23	24	22	22
12. Reabsorber gas in x 205.856 (10^3 scf/d)	.5/102.9(10^3)	.5/102.9(10^3)	.5/1029(10^3)	.5/102.9(10^3)	.5/102.9(10^3)
13. Natural gas in x 169.044 (10^3 scf/d)	0/0	0/0	0/0	0/0	0/0
14. Fuel oil in (P) psig/Gas in (P)	62/3.0	62/3.0	62/3.0	62/2.5	62/2.5
15. Gas Fuel P/~~steam~~ oil P (psig)/Steam P	—	—	—	—	—
16. Burner #1	0/58/82	—	–/58/82	0/–/–	–
17. Burner #2	1.2/52/82	—	–/52/82	.8/–/–	–
18. Burner #3	2.2/54/84	—	–/54/84	2.0/–/–	–
19. Burner #4	3.0/56/86	—	–/56/86	2.6/–/–	–
20. Burner #5	1.2/57/83	—	–/56/82	1.0/–/–	–
21. Burner #6	3.2/42/82	—	–/42/82	2.6/–/–	–

Fuel Oil Flow (bbl/d)

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UNIT OPERATING DATA - CONTINUED

Test No. 2/22-1-5 Date 2/22/83 Location Site #2 Engr. Benson

Unit No. 11H13 Fuel 80% oil/20% Gas Rated Capacity 14K BBL/D

Unit Type Refinery Process Heater Burner Type DBA-22 Oil/Gas

Test Description:	Baseline 2/22-1	4' SCA (FD) Max. BEP, 6% O_2 2/22-2	4' SCA (FD) Max. BEP 5% O_2 2/22-3	4' SCA (FD) Max. BEP 4% O_2 2/22-4	4' SCA (FD) Max. BEP 3% O_2 2/22-5
22. Tube Skin Temperatures (°F)					
23. 13A	742	754	772	782	788
24. 15A	715	732	745	755	763
25. 20A	726	727	743	764	772
26. 25A	767	763	777	795	802
27. 13B	721	744	751	755	763
28. 15B	704	727	735	744	748
29. 20B	742	759	763	769	766
30. 25B	761	770	776	791	793
31. Staging Height (ft)	—	4	4	4	4
32. Staging Air P (iwg)	—	.9	.9	.9	.9
33. Staging Air T (°F)	—	—	—	—	—
34. Stack T (°F)	748	741	723	701	685
35. Fuel Oil T (°F)	—	—	—	—	—
36. Stack Damper (% open)	1st notch	Closed a bit from Baseline	Closed Down a little more	Closed Down Further	Closed Down Further
37. Bottom Furnace P (iwg)	-.35	-.29	-.37	-.36	-.39
38. Convective P (iwg)	+.14	+.10	+.24	+.27	+.20
39. Stack P (iwg)	+.06	+.12	+.15	+.10	+.22
40. Air Registers (% open)	50	40	33	25	10
41. Crude API Gravity	21.0	21.0	21.0	21.0	21.0
42. Flame Observations	#5 Little smoky at flame top	No visible change of flame height		Flames 1-2 ft. taller than Baseline	Smoky
43. Other Observations	Bright well defined flames #1-6			Little smokier	

UNIT OPERATING DATA

Test No. 2/22-7 Date 2/22/83 Location Site # 2 Engr. Benson
Unit No. 11H13 Fuel 80% oil/20% Gas Rated Capacity 14K BBL/D
Unit Type Refinery Process Heater Burner Type DBA-22 Oil/Gas
Test Description: Baseline, Report

1. Test Number	2/22-7				
2. Date	2/22/83				
3. Time	1800				
4. Load x 10^6 Btu/hr	46.5				
5. Process Rate x 1847.7 bbl/d	6.2/11456				
6. Crude T_{in} (°F)	350				
7. Crude T_{out} (°F) East	650				
8. Crude T_{out} (°F) West	646				
9. Crude P_{in} (psig) East	90				
10. Crude P_{in} (psig) West	95				
11. Crude P_{out} (psig)	22				
12. Reabsorber gas in x 205.856 (10^3 scf/d)	0/-				
13. Natural gas in x 169.044 (10^3 scf/d)	.8/135.2(10^3)				
14. Fuel oil in (P) psig/Gas in (P)	62/2.0				
15. GAS Fuel P/~~steam~~ oil P (psig)/steam P	—				
16. Burner #1	-/58/82				
17. Burner #2	1.0/52/83				
18. Burner #3	2.0/54/84				
19. Burner #4	2.8/56/86				
20. Burner #5	-/57/82				
21. Burner #6	-/42/82				

Fuel Oil Flow (bbl/d) 144

UNIT OPERATING DATA - CONTINUED

Test No. 2/22-7 Date 2/22/83 Location Site #2 Engr. Benson

Unit No. 11H13 Fuel 80% oil/20% Gas Rated Capacity 14K BBL/D

Unit Type Refinery Process Heater Burner Type DBA-22 Oil/Gas

Test Description: Baseline

	2/22-7				
22. Tube Skin Temperatures (°F)					
23. 13A	738				
24. 15A	726				
25. 20A	722				
26. 25A	754				
27. 13B	729				
28. 15B	715				
29. 20B	754				
30. 25B	756				
31. Staging Height (ft)	—				
32. Staging Air P (iwg)	—				
33. Staging Air T (°F)	—				
34. Stack T (°F)	722				
35. Fuel Oil T (°F)	—				
36. Stack Damper (% open)	Back to Baseline				
37. Bottom Furnace P (iwg)	-.33				
38. Convective P (iwg)	+.18				
39. Stack P (iwg)	+.09				
40. Air Registers (% open)	50				
41. Crude API Gravity	21				
42. Flame Observations	Good Flame				
43. Other Observations					

UNIT OPERATING DATA

Test No. 2/23-1-4 Date 2/23/83 Location Site #2 Engr. Benson

Unit No. 11H13 Fuel 80% oil/20% Gas Rated Capacity 14 K BBL/D

Unit Type Refinery Process Heater Burner Type DBA-22 oil/gas

Test Description:	Baseline	4' SCA (FD) Med. BER, 6% O2	4' SCA (FD) Med. BER, 5% O2	4' SCA (FD) Med. BER, 4% O2	Repeat 2/23-4
1. Test Number	2/23-1	2/23-2	2/23-3	2/23-4	2/23-4R
2. Date	2/23/83	2/23/83	2/23/83	2/23/83	2/23/83
3. Time	1035	1118	1150	1300	1630
4. Load x 10^6 Btu/hr	46.1	46.1	46.1	46.1	46.1
5. Process Rate x 1847.7 bbl/d	6.2/11456	6.2/11456	6.2/11456	6.2/11456	6.2/11456
6. Crude T_{in} (°F)	355	355	353	350	350
7. Crude T_{out} (°F) East	652	652	650	650	648
8. Crude T_{out} (°F) West	652	653	650	649	644
9. Crude P_{in} (psig) East	90	88	90	88	85
10. Crude P_{in} (psig) West	95	93	95	95	90
11. Crude P_{out} (psig)	20	22.5	21.5	21.5	21.0
12. Reabsorber gas in x 205.856 (10^3 scf/d)	—	—	—	—	—
13. Natural gas in x 169.044 (10^3 scf/d)	1.0/169.0(10^3)	1.0/169.0(10^3)	1.0/169.0(10^3)	1.0/169.0(10^3)	1.0/169.0(10^3)
14. Fuel oil in (P) psig/Gas in (P)	62/1.5	62/1.5	62/1.5	62/1.0	56/2.5
15. Gas Fuel P/~~steam~~ Oil P (psig)/Steam P	—	—	—	—	—
16. Burner #1	0/58/82	—	—	0/58/80	0/52/77
17. Burner #2	.8/52/82	—	—	0/52/82	1.6/48/77
18. Burner #3	2.0/54/84	—	—	1.6/54/83	3.6/49/78
19. Burner #4	2.6/55/85	—	—	2.2/55/84	3.2/50/80
20. Burner #5	1.0/57/82	—	—	.4/57/82	1.8/52/77
21. Burner #6	2.8/40/81	—	—	2.2/40/80	3.4/40/76
Fuel Oil Flow (bbl/d)	141	142	143	142	104

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UNIT OPERATING DATA - CONTINUED

Test No. 2/23-1-4 Date 2/23/83 Location Site #2 Engr. Benson

Unit No. 11H13 Fuel 80% Oil/20% Gas Rated Capacity 14K BBL/D

Unit Type Refinery Process Heater Burner Type DBA-22 Oil/Gas

Test Description:

	Baseline 2/23-1	4' SCA (FD) Med. BER, 6% O_2 2/23-2	4' SCA (FD) Med. BER, 5% O_2 2/23-3	4' SCA (FD) Med. BER 4% O_2 2/23-4	Repeat 2/23-4 2/23-4R
22. Tube Skin Temperatures (°F)					
23. 13A	741	747	749	746	734
24. 15A	728	742	746	740	736
25. 20A	729	735	742	750	733
26. 25A	772	782	792	797	779
27. 13B	725	758	766	771	744
28. 15B	711	747	750	755	741
29. 20B	748	762	768	772	766
30. 25B	771	781	789	796	782
31. Staging Height (ft)	—	4	4	4	4
32. Staging Air P (iwg)	—	1.95	1.95	1.95	1.95
33. Staging Air T (°F)	—	—	—	—	—
34. Stack T (°F)	737	716	700	683	676
35. Fuel Oil T (°F)	Baseline	Closed Down A Little	Closed Down Further	Closed Down Further	—
36. Stack Damper (% open)	Baseline	Closed Down A Little	Closed Down More	Same as 2/23-3	Same as 2/23-3
37. Bottom Furnace P (iwg)	-.35	-.31	-.35	-.38	-.20
38. Convective P (iwg)	+.18	+.18	+.20	+.22	+.22
39. Stack P (iwg)	+.16	+.13	+.08	+.18	+.25
40. Air Registers (% open)	50	40	33	25	33
41. Crude API Gravity	20.7	20.7	20.7	20.7	20.7
42. Flame Observations	Bright, Well Defined		Smoky Furnace		Good Fire
43. Other Observations					

UNIT OPERATING DATA

Test No. 2/23-5-8 Date 2/23/83 Location Site #2 Engr. Benson

Unit No. 11H13 Fuel 80% Oil/20% Gas Rated Capacity 14 K BBL/D

Unit Type Refinery Process Heater Burner Type DBA-22 Oil/Gas

Test Description: 4' SCA (FD) MED BER Baseline, Repeat

1. Test Number	2/23-5,7	2/23-8			
2. Date	2/23/83	2/23/83			
3. Time	1706	1755			
4. Load x 10^6 Btu/hr	36.5	36.5			
5. Process Rate x 1847.7 bbl/d	6.2/11456	6.2/11456			
6. Crude T_{in} (°F)	350	350			
7. Crude T_{out} (°F) East	648	652			
8. Crude T_{out} (°F) West	648	644			
9. Crude P_{in} (psig) East	88	88			
10. Crude P_{in} (psig) West	92	92			
11. Crude P_{out} (psig)	22	22			
12. Reabsorber gas in x 205.856 (10^3 scf/d)	0	0			
13. Natural gas in x 169.044 (10^3 scf/d)	1.0/169.044(10^3)	1.0/169.044(10^3)			
14. Fuel oil in (P) psig/Gas in (P)	56/2.5	56/2.5			
15. Fuel P/~~steam~~ Oil P (psig)/Steam P	—	—			
16. Burner #1	—	0/52/77			
17. Burner #2	—	1.6/48/77			
18. Burner #3	—	3.6/49/78			
19. Burner #4	—	3.2/50/80			
20. Burner #5	—	1.8/52/77			
21. Burner #6	—	3.4/40/76			
Fuel Oil Flow (bbl/d)	103	109			

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UNIT OPERATING DATA - CONTINUED

Test No. 2/23-5-8 Date 2/23/83 Location Site # 2 Engr. Benson

Unit No. 11H13 Fuel 80% Oil/20% Gas Rated Capacity 14K BBL/D

Unit Type Refinery Process Heater Burner Type DBA-22 Oil/Gas

Test Description:

	4' SCA(FD) Med. BER 2/23-5,7	Baseline, Repeat 2/23-8			
22. Tube Skin Temperatures (°F)					
23. 13A	741	725			
24. 15A	746	713			
25. 20A	752	718			
26. 25A	810	756			
27. 13B	752	718			
28. 15B	747	702			
29. 20B	769	746			
30. 25B	806	762			
31. Staging Height (ft)	4	—			
32. Staging Air P (iwg)	1.95	—			
33. Staging Air T (°F)	—	—			
34. Stack T (°F)	653	722			
35. Fuel Oil T (°F)	—	—			
36. Stack Damper (% open)	Closed 2 notches	Baseline			
37. Bottom Furnace P (iwg)	-.20	-.33			
38. Convective P (iwg)	+.22	+.27			
39. Stack P (iwg)	+.09	+.22			
40. Air Registers (% open)	25	50			
41. Crude API Gravity	20.7	20.7			
42. Flame Observations					
43. Other Observations					

UNIT OPERATING DATA

Test No. 2/24-1-4 Date 2/24/83 Location Site #2 Engr. Benson

Unit No. 11H13 Fuel 80% Oil/20% Gas Rated Capacity 14 K BBL/D

Unit Type Refinery Process Heater Burner Type DBA-22 Oil/Gas

Test Description:	Baseline	4' SCA (FD) Min. BEP, 6% O_2	4' SCA (FD) Min. BEP, 5% O_2	Baseline, Repeat	
1. Test Number	2/24-1	2/24-2	2/24-3,4	2/24-5	
2. Date	2/24/83	2/24/83	2/24/83	2/24/83	
3. Time	1256	1556	1651	1800	
4. Load x 10^6 Btu/hr	32.1	32.1	32.1	28.2	
5. Process Rate x 1847.7 bbl/d	6.23/11511	6.23/11511	6.25/11548	6.25/11548	
6. Crude T_{in} (°F)	405	405	408	405	
7. Crude T_{out} (°F) East	642	634	635	642	
8. Crude T_{out} (°F) West	651	662	664	654	
9. Crude P_{in} (psig) East	95	98	97	95	
10. Crude P_{in} (psig) West	90	90	90	90	
11. Crude P_{out} (psig)	21	22	22	22	
12. Reabsorber gas in x 205.856 (10^3 scf/d)	—	—	—	—	
13. Natural gas in x 169.044 (10^3 scf/d)	.7/118.3(10^3)	.7/118.3(10^3)	.7/118.3(10^2)	.7/118.3(10^3)	
14. Fuel oil in (P) psig/Gas in (P)	54/2.2	54/2.2	54/2.2	54/2.2	
15. Gas Fuel P/~~steam~~ Oil P (psig)/Steam P	—	—	—	—	
16. Burner #1	0/50/76	0/50/76	0/50/76	0/50/76	
17. Burner #2	.8/46/76	.8/46/78	.8/46/78	.8/46/76	
18. Burner #3	1.8/48/78	1.8/47/78	1.8/48/78	1.8/48/78	
19. Burner #4	2.6/48/78	2.6/48/80	2.6/48/80	2.6/48/78	
20. Burner #5	.8/50/76	.8/49/77	.8/50/76	.8/50/76	
21. Burner #6	2.6/39/79	2.8/40/76	2.6/40/76	2.6/39/79	
Fuel Oil Flow (bbl/d)	100	100	98	84	

UNIT OPERATING DATA - CONTINUED

Test No. 2/24-1-4 Date 2/24/83 Location Site #2 Engr. Benson

Unit No. 11H13 Fuel 80% Oil/20% Gas Rated Capacity 14K BBL/D

Unit Type Refinery Process Heater Burner Type DBA-22 Oil/Gas

Test Description:

	Baseline 2/24-1	4'SCA(FD) Min. BER, 6% O2 2/24-2	4'SCA(FD) Min. BER, 5% O2 2/24-3,4	Baseline, Repeat 2/24-5	
22. Tube Skin Temperatures (°F)					
23. 13A	729	756	758	720	
24. 15A	707	749	754	698	
25. 20A	715	741	745	714	
26. 25A	744	783	785	743	
27. 13B	700	702	701	696	
28. 15B	683	700	705	679	
29. 20B	718	734	741	720	
30. 25B	735	761	763	734	
31. Staging Height (ft)	–	4	4	–	
32. Staging Air P (iwg)	–	4.5	4.5	–	
33. Staging Air T (°F)	–	–	–	–	
34. Stack T (°F)	703	667	653	696	
35. Fuel Oil T (°F)	–	–	–	–	
36. Stack Damper (% open)	Closed Down to 2nd notch	Same as 2/24-1	Closed Down A Little From 2/24-1	Same as 2/24-1	
37. Bottom Furnace P (iwg)	-.22	-.13	-.13	-.23	
38. Convective P (iwg)	+.11	+.16	+.31	+.12	
39. Stack P (iwg)	+.15	+.17	+.31	+.05	
40. Air Registers (% open)	50 except Burner #5, 75	33 except Burner #5	#1 20 #4 30 2 10 5 70 3 10 6 10	Same as 2/24-1	
41. Crude API Gravity	20.7	20.7	20.7	20.7	
42. Flame Observations	Good Fire	Burner #6 Little Smoky	Good Fire		
43. Other Observations					

UNIT OPERATING DATA

Test No. 2/25-1-5 Date 2/25/83 Location Site #2 Engr. Benson

Unit No. 11H13 Fuel 80% oil/20% Gas Rated Capacity 14 K BBL/D

Unit Type Refinery Process Heater Burner Type DBA-22 oil/gas

Test Description:

	Baseline	3' SCA (FD) Max. BER	3' SCA (FD) Med. BER	3' SCA (FD) Min. BER	Baseline, Repeat
1. Test Number	2/25-1	2/25-2	2/25-3	2/25-4	2/25-5
2. Date	2/25/83	2/25/83	2/25/83	2/25/83	2/25/83
3. Time	0945	1026	1115	1190	1215
4. Load x 10^6 Btu/hr	25.3	25.3	25.3	25.3	17.3
5. Process Rate x 1847.7 bbl/d	4.3/7945	4.3/7945	4.3/7945	4.3/7945	4.3/7945
6. Crude T_{in} (°F)	450	450	450	450	451
7. Crude T_{out} (°F) East	650	649	644	640	638
8. Crude T_{out} (°F) West	650	645	634	627	648
9. Crude P_{in} (psig) East	98	94	100	100	95
10. Crude P_{in} (psig) West	92	100	95	92	100
11. Crude P_{out} (psig)	22	23	22	22.5	23.1
12. Reabsorber gas in x 205.856 (10^3 scf/d)	0	0	0	0	0
13. Natural gas in x 169.044 (10^3 scf/d)	.5/84.5(10^3)	.5/84.5(10^3)	.5/84.5(10^3)	.5/84.5(10^3)	.5/84.5(10^3)
14. Fuel oil in (P) psig/Gas in (P)	50/2.0	51/-	50/1.5	46/1.0	46/1.5
15. Gas Fuel P/~~steam~~ Oil P (psig)/Steam P	—	—	—	—	—
16. Burner #1	0/46/74	0/46/74	—	—	0/42/71
17. Burner #2	0/44/74	0/44/74	—	—	0/40/70
18. Burner #3	1.4/45/76	1.4/44/75	—	—	1.8/40/74
19. Burner #4	2.0/45/76	2.0/45/77	—	—	2.4/41/75
20. Burner #5	0/46/74	0/46/74	—	—	0/42/72
21. Burner #6	2.2/40/76	2.1/40/73	—	—	2.6/40/71
Fuel Oil Flow (bbl/d)	75	83	80	77	—

UNIT OPERATING DATA - CONTINUED

Test No. 2/25-1-5 Date 2/25/83 Location Site # 2 Engr. Benson

Unit No. 11H13 Fuel 80% Oil/20% Gas Rated Capacity 14K BBL/D

Unit Type Refinery Process Heater Burner Type DBA-22 Oil/Gas

Test Description:

	Baseline 2/25-1	3' SCA (FD) Max. BER. 2/25-2	3' SCA (FD) Med. BER 2/25-3	3' SCA (FD) Min. BER 2/25-4	Baseline, Repeat 2/25-5
22. Tube Skin Temperatures (°F)					
23. 13A	715	732	703	707	710
24. 15A	684	708	685	707	680
25. 20A	715	717	699	703	701
26. 25A	728	736	728	726	729
27. 13B	704	713	721	733	699
28. 15B	675	685	693	731	671
29. 20B	712	718	722	728	709
30. 25B	727	732	736	741	722
31. Staging Height (ft)	–	3	3	3	–
32. Staging Air P (iwg)	–	.9	2.0	4.5	–
33. Staging Air T (°F)	–	–	–	–	–
34. Stack T (°F)	673	663	651	615	672
35. Fuel Oil T (°F)	–	–	–	–	–
36. Stack Damper (% open)	Little past 2nd notch	Same	Same	closed more	Baseline pt.
37. Bottom Furnace P (iwg)	-.23	-.21	-.19	-.10	-.27
38. Convective P (iwg)	+.18	+.15	+.12	+.25	+.14
39. Stack P (iwg)	+.23	+.27	+.25	+.35	+.23
40. Air Registers (% open)	33	10	10	10	33
41. Crude API Gravity	21.9	21.9	21.9	21.9	21.9
42. Flame Observations	Very short well defined flames	Short flame low firing	Shorter flames little smokier		short
43. Other Observations	viewport Height	rate	in furnace		

UNIT OPERATING DATA

Test No. 2/28-1-5 Date 2/28/83 Location Site #2 Engr. Benson

Unit No. 11H13 Fuel 80% oiL/20% GAS Rated Capacity 14 K BBL/D

Unit Type Refinery Process Heater Burner Type DBA-22 oiL/GAS

Test Description:	Baseline	4' SCA (FD) Max. BER	4' SCA (FD) Med. BER	4' SCA (FD) Min. BER	Baseline Repeat
1. Test Number	2/28-1	2/28-2	2/28-3	2/28-4	2/28-5
2. Date	2/28/83	2/28/83	2/28/83	2/28/83	2/28/83
3. Time	1030	1143	1310	1410	1427
4. Load x 10^6 Btu/hr	42.8	42.8	37.0	37.0	37.0
5. Process Rate x 1847.7 bbl/d	7.6/14000	7.6/14000	7.6/14000	7.6/14000	7.6/14000
6. Crude T_{in} (°F)	380	378	380	375	395
7. Crude T_{out} (°F) East	646	642	646	645	638
8. Crude T_{out} (°F) West	649	654	654	652	650
9. Crude P_{in} (psig) East	92	95	90	95	95
10. Crude P_{in} (psig) West	100	100	95	100	100
11. Crude P_{out} (psig)	24.5	23.5	22.5	24	22.5
12. Reabsorber gas in x 205.856 (10^3 scf/d)	0	0	0	0	0
13. Natural gas in x 169.044 (10^3 scf/d)	.8/135.24 (10^3)	.8/135.24 (10^3)	.8/135.24 (10^3)	.8/135.24 (10^3)	.8/135.24 (10^3)
14. Fuel oil in (P) psig/Gas in (P)	61/1.3	61/1.1	58/1.3	59/1.3	52/1.5
15. GAS Fuel P/~~steam~~ OIL P (psig)/Steam P	—	—	—	—	—
16. Burner #1	0/56/81	0/56/81	0/56/78	–/54/78	0/50/75
17. Burner #2	.2/52/82	0/52/82	.3/50/80	–/50/80	.8/46/75
18. Burner #3	1.6/54/84	1.6/54/83	1.8/52/80	–/52/80	2.2/46/75
19. Burner #4	2.2/55/85	2.2/54/84	2.4/52/82	–/52/82	2.8/48/76
20. Burner #5	.3/56/82	0/56/82	.6/54/80	–/54/80	1.0/49/76
21. Burner #6	2.4/40/81	2.4/40/81	2.6/40/78	–/40/79	3.0/40/74
Fuel Oil Flow (bbl/d)	135	136	114	113	91

UNIT OPERATING DATA - CONTINUED

Test No. 2/28-1-5 Date 2/28/83 Location Site #2 Engr. Benson

Unit No. 11H13 Fuel 80% Oil/20% Gas Rated Capacity 14K BBL/D

Unit Type Refinery Process Heater Burner Type DBA-22 Oil/Gas

Test Description:	Baseline 2/28-1	4' SCA(FD) Max. BER 2/28-2	4' SCA(FD) Med. BER 2/28-3	4' SCA(FD) Min. BER 2/28-4	Baseline Repeat 2/28-5
22. Tube Skin Temperatures (°F)					
23. 13A	758	765	759	831	735
24. 15A	728	737	755	834	702
25. 20A	736	738	740	784	714
26. 25A	764	771	783	831	744
27. 13B	729	724	742	773	700
28. 15B	704	703	739	790	670
29. 20B	743	738	756	796	713
30. 25B	761	760	789	827	731
31. Staging Height (ft)	–	4	4	4	–
32. Staging Air P (iwg)	–	1.15	2.45	4.4	–
33. Staging Air T (°F)	–	–	–	–	–
34. Stack T (°F)	714	688	674	643	708
35. Fuel Oil T (°F)	–	–	–	–	–
36. Stack Damper (% open)	Baseline	closed some	–	–	Baseline
37. Bottom Furnace P (iwg)	-.37	-.25	-.32	-.18-.23	-.40
38. Convective P (iwg)	+.07	+.07	+.23	+.19	+.07
39. Stack P (iwg)	+.12	+.22	+.23-.28	+.23-.28	+.07
40. Air Registers (% open)	Reg. 1,2,3,4,6 33 5 70	25 50	no change	no change	1,2,3,4,6 33 5 70
41. Crude API Gravity	21.2	21.2	21.2	21.2	21.2
42. Flame Observations					
43. Other Observations					

UNIT OPERATING DATA

Test No. 6/8-1 And 6/9-1-3 Date 6/8/83-6/9/83 Location Site #2 Engr. Benson

Unit No. 11H13 Fuel 80% oil/20% Gas Rated Capacity 14K BBL/D

Unit Type Refinery Process Heater Burner Type DBA-22 oil/gas

Test Description:

	Baseline	Baseline	Low NO_x	Low NO_x	Low NO_x
1. Test Number	6/8-1	6/9-1	6/9-2	6/9-2	6/9-3
2. Date	6/8/83	6/9/83	6/9/83	6/9/83	6/9/83
3. Time	1516	0746	1130	1415	1651
4. Load x 10^6 Btu/hr	53.4	46.2	45.7	45.7	47.4
5. Process Rate x 1847.7 bbl/d	6.31/11640	6.3/11640	6.3/11640	6.3/11640	6.3/11640
6. Crude T_{in} (°F)	373	370	370	373	370
7. Crude T_{out} (°F) East	645	644	639	639	636
8. Crude T_{out} (°F) West	660	663	665	666	663
9. Crude P_{in} (psig) East	144	140	137	137	135
10. Crude P_{in} (psig) West	146	143	140	140	140
11. Crude P_{out} (psig)	42.5	41	41	41	39
12. Reabsorber gas in x 205.856 (10^3 scf/d)	1.6/329.36 (10^3)	1.5/308.78 (10^3)	1.7/349.96 (10^3)	1.6/329.36 (10^3)	1.8/370.54 (10^3)
13. Natural gas in x 169.044 (10^3 scf/d)	0	0	0	0	0
14. Fuel oil in (P) psig/Gas in (P)	62/5.8	58/5.5	54/6.2	55/6.2	55/6.5
15. Fuel P/~~steam~~ oil P (psig)/Steam P	—	—	—	—	—
16. Burner #1	3.5/45/80	3.0/40/80	4.0/40/76	4.0/40/76	4.0/36/76
17. Burner #2	7.8/50/82	7.2/50/80	6.0/50/76	5.0/50/76	5.6/50/76
18. Burner #3	5.0/58/82	4.4/56/82	7.2/50/76	6.8/50/80	7.0/50/80
19. Burner #4	6.2/58/82	6.0/56/82	7.6/50/80	7.0/52/80	7.4/50/80
20. Burner #5	6.2/56/81	6.2/54/80	6.0/50/76	5.6/50/76	6.6/50/76
21. Burner #6	4.7/56/81	4.4/54/82	7.2/50/76	7.8/50/78	8.2/50/76
Fuel Oil Flow (bbl/d)	128		116	92	60

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UNIT OPERATING DATA - CONTINUED

Test No. 6/8-1 and 6/9-1-3 Date 6/8/83-6/9/83 Location Site # 2 Engr. Benson

Unit No. 11H13 Fuel 80% Oil/20% Gas Rated Capacity 14K BBL/D

Unit Type Refinery Process Heater Burner Type DBA-22 Oil/Gas

Test Description:	Baseline 6/8-1	Baseline 6/9-1	Low NOx 6/9-2	Low NOx 6/9-2	Low NOx 6/9-3
22. Tube Skin Temperatures (°F)					
23. 13A	812	803	855	862	860
24. 15A	761	755	800	816	810
25. 20A	776	778	789	795	789
26. 25A	808	808	819	825	822
27. 13B	749	743	767	770	775
28. 15B	738	732	774	782	789
29. 20B	782	778	787	794	803
30. 25B	792	778	802	—	—
31. Staging Height (ft)	—	—	4	4	4
32. Staging Air P (iwg)	—	—	1.4	1.4	1.4
33. Staging Air T (°F)	—	—	—	—	—
34. Stack T (°F)	776	775	694	689	690
35. Fuel Oil T (°F)	—	—	—	—	—
36. Stack Damper (% open)	100	100	Closed Down to 1st notch	Same as 6/9-1	—
37. Bottom Furnace P (iwg)	-.27	-.32	-.17	-.15	-.13
38. Convective P (iwg)	-.15	-.19	-.09	-.07	-.07
39. Stack P (iwg)	+.14	0	-.05	+.04	+.07
40. Air Registers (% open)	100	100	50-60	50-60	50-60
41. Crude API Gravity	27.6	27.6	27.6	27.6	27.6
42. Flame Observations			#1 Burner Bad Atomizing		
43. Other Observations					

UNIT OPERATING DATA

Test No. 3/2-1 Date 3/2/83 Location Site #2 Engr. Benson

Unit No. 11H13 Fuel 80% Oil/20% Gas Rated Capacity 14 K BBL/D

Unit Type Refinery Process Heater Burner Type DBA-22 Oil/Gas

Test Description: Baseline

1. Test Number	3/2-1	3/2-1	3/2-1	3/2-1	
2. Date	3/2/83	3/2/83	3/2/83	3/2/83	
3. Time	0900	1145	1628	1843	
4. Load x 10^6 Btu/hr	40.4	40.4	40.4	40.4	
5. Process Rate x 1847.7 bbl/d	6.2/11460	6.2/11460	6.2/11460	6.2/11460	
6. Crude T_{in} (°F)	385	383	385	385	
7. Crude T_{out} (°F) East	648	656	642	642	
8. Crude T_{out} (°F) West	654	656	651	644	
9. Crude P_{in} (psig) East	85	85	85	85	
10. Crude P_{in} (psig) West	80	80	80	80	
11. Crude P_{out} (psig)	18.5	20.0	19.0	21.5	
12. Reabsorber gas in x 205.856 (10^3 scf/d)	0	0	0	0	
13. Natural gas in x 169.044 (10^3 scf/d)	.7/118.3(10^3)	.7/118.3(10^3)	.7/118.3(10^3)	.7/118.3(10^3)	
14. Fuel oil in (P) psig/Gas in (P)	54/1.0	52/1.1	52/1.3	52/1.5	
15. Gas Fuel P/~~steam~~ Oil P (psig)/Steam P	—	—	—	—	
16. Burner #1	0/50/75	0/48/74	0/48/74	0/48/74	
17. Burner #2	0/46/78	0/44/74	.4/45/74	.8/45/75	
18. Burner #3	1.6/47/77	1.6/46/76	1.8/46/76	2.0/46/77	
19. Burner #4	2.0/48/78	2.2/46/76	2.4/47/77	2.6/47/78	
20. Burner #5	0/50/75	0/48/74	.8/46/74	1.0/48/78	
21. Burner #6	2.2/40/75	2.4/40/73	2.6/40/74	2.8/40/74	
Fuel Oil Flow (bbl/d)	—	—	—	112	

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UNIT OPERATING DATA - CONTINUED

Test No. 3/2-1 Date 3/2/83 Location Site #2 Engr. Benson

Unit No. 11H13 Fuel 80% Oil/20% Gas Rated Capacity 14K BBL/D

Unit Type Refinery Process Heater Burner Type DBA-22 Oil/Gas

Test Description: Baseline

	3/2-1	3/2-1	3/2-1	3/2-1	
22. Tube Skin Temperatures (°F)					
23. 13A	727	736	717	706	
24. 15A	700	714	691	688	
25. 20A	714	714	706	700	
26. 25A	744	746	736	732	
27. 13B	700	696	691	686	
28. 15B	680	686	671	671	
29. 20B	716	715	708	708	
30. 25B	735	734	726	728	
31. Staging Height (ft)	—	—	—	—	
32. Staging Air P (iwg)	—	—	—	—	
33. Staging Air T (°F)	—	—	—	—	
34. Stack T (°F)	695	688	691	695	
35. Fuel Oil T (°F)	—	—	—	—	
36. Stack Damper (% open)	—	no change	no change	no change	
37. Bottom Furnace P (iwg)	-.30	—	-.24	-.25	
38. Convective P (iwg)	+.23	—	+.07	+.11	
39. Stack P (iwg)	+.17	—	+.07	+.11	
40. Air Registers (% open)	#1,2,3,4,6 50 #5 70	no change	no change	no change	
41. Crude API Gravity	21.1	21.1	21.1	21.1	
42. Flame Observations	Short well Defined Flames (9-10)				
43. Other Observations		Smoke spot #3 through viewport #4	Smoke spot #1,5 through viewport #4		

UNIT OPERATING DATA

Test No. 3/3-1 Date 3/3/83 Location Site #2 Engr. Benson

Unit No. 11H13 Fuel 80% Oil/20% Gas Rated Capacity 14 K BBL/D

Unit Type Refinery Process Heater Burner Type DBA-22 Oil/Gas

Test Description: Baseline

1. Test Number	3/3-1	3/3-1	3/3-1		
2. Date	3/3/83	3/3/83	3/3/83		
3. Time	0850	1115	1500		
4. Load x 10^6 Btu/hr	40.4	40.4	40.4		
5. Process Rate x 1847.7 bbl/d	6.2/11455	6.2/11455	6.2/11455		
6. Crude T_{in} (°F)	385	410	405		
7. Crude T_{out} (°F) East	643	645	644		
8. Crude T_{out} (°F) West	651	649	644		
9. Crude P_{in} (psig) East	85	100	100		
10. Crude P_{in} (psig) West	80	95	95		
11. Crude P_{out} (psig)	18.0	28.5	25.0		
12. Reabsorber gas in x 205.856 (10^3 scf/d)	0	0	0		
13. Natural gas in x 169.044 (10^3 scf/d)	1.0/169.04(10^3)	1.0/169.04(10^3)	1.0/169.04(10^3)		
14. Fuel oil in (P) psig/Gas in (P)	52/1.7	53/2.0	56/1.8		
15. Gas Fuel P/~~steam~~ Oil P (psig)/Steam P	—	—	—		
16. Burner #1	0/48/76	0/49/76	0/52/78		
17. Burner #2	1.0/46/76	1.4/46/77	1.2/48/78		
18. Burner #3	2.2/46/78	2.4/46/78	2.4/50/80		
19. Burner #4	2.8/46/79	3.0/48/80	3.0/50/80		
20. Burner #5	1.0/48/76	1.4/48/76	1.2/52/78		
21. Burner #6	3.0/40/75	3.4/42/76	3.2/41/77		
Fuel Oil Flow (bbl/d)	141	188	95		

Videospec readings fluctuating wildly this day.

UNIT OPERATING DATA - CONTINUED

Test No. 9/3-1 Date 9/3/83 Location Site #2 Engr. Benson

Unit No. 11H13 Fuel 80% Oil/20% Gas Rated Capacity 14K BBL/D

Unit Type Refinery Process Heater Burner Type DBA-22 Oil/Gas

Test Description:

	9/3-1	9/3-1	9/3-1		
22. Tube Skin Temperatures (°F)					
23. 13A	713	720	720		
24. 15A	684	700	700		
25. 20A	705	713	712		
26. 25A	734	746	738		
27. 13B	687	703	705		
28. 15B	670	689	689		
29. 20B	706	723	725		
30. 25B	724	714	738		
31. Staging Height (ft)	—	—	—		
32. Staging Air P (iwg)	—	—	—		
33. Staging Air T (°F)	—	—	—		
34. Stack T (°F)	698	714	737		
35. Fuel Oil T (°F)	—	—	—		
36. Stack Damper (% open)	—	—	—		
37. Bottom Furnace P (iwg)	-.21	-.23	—		
38. Convective P (iwg)	+.10	+.09	—		
39. Stack P (iwg)	+.06	+.14	—		
40. Air Registers (% open)	33	33	33		
41. Crude API Gravity	21.1	21.1	21.1		
42. Flame Observations					
43. Other Observations					

UNIT OPERATING DATA

Test No. 3/4-1 Date 3/4/83 Location Site #2 Engr. Benson

Unit No. 11H13 Fuel 80% oil/20% Gas Rated Capacity 14 K BBL/D

Unit Type Refinery Process Heater Burner Type DBA-22 oil/Gas

Test Description: Baseline

1. Test Number	3/4-1	3/4-1	3/4-1	3/4-1	
2. Date	3/4/83	3/4/83	3/4/83	3/4/83	
3. Time	0900	1015	1220	1320	
4. Load x 10^6 Btu/hr	38.9	38.9	38.9	38.9	
5. Process Rate x 1847.7 bbl/d	6.3/11640	6.3/11640	6.3/11640	6.3/11640	
6. Crude T_{in} (°F)	405	395	400	400	
7. Crude T_{out} (°F) East	649	638	640	640	
8. Crude T_{out} (°F) West	654	647	647	648	
9. Crude P_{in} (psig) East	95	95	95	95	
10. Crude P_{in} (psig) West	90	90	90	90	
11. Crude P_{out} (psig)	21.0	22.5	20-23	22.5	
12. Reabsorber gas in x 205.856 (10^3 scf/d)	0	0	0	0	
13. Natural gas in x 169.044 (10^3 scf/d)	.8/135.23(10^3)	.8/135.23(10^3)	.8/135.23(10^3)	.8/135.29(10^3)	
14. Fuel oil in (P) psig/Gas in (P)	58/1.2	56/1.2	56/1.5	56/1.4	
15. Gas Fuel P/~~steam~~ oil P (psig)/Steam P	—	—	—	—	
16. Burner #1	0/52/77	—	0/52/77	0/52/77	
17. Burner #2	0/48/78	—	.5/48/78	.3/48/78	
18. Burner #3	1.6/50/80	—	1.8/50/80	1.8/50/80	
19. Burner #4	2.2/50/80	—	2.4/50/80	2.4/52/80	
20. Burner #5	0/52/78	—	.5/52/78	.3/52/76	
21. Burner #6	2.4/40/77	—	2.6/40/78	2.6/40/77	
Fuel Oil Flow (bbl/d)	171	0	148	0	

videospecs readings fluctuating Dramatically!

UNIT OPERATING DATA - CONTINUED

Test No. 3/4-1 Date 3/4/83 Location Site #2 Engr. Benson

Unit No. 11H13 Fuel 80% Oil/20% Gas Rated Capacity 14K BBL/D

Unit Type Refinery Process Heater Burner Type DBA-22 Oil/Gas

Test Description: Base Line

	3/4-1	3/4-1	3/4-1	3/4-1	
22. Tube Skin Temperatures (°F)					
23. 13A	724	718	717	718	
24. 15A	694	687	687	692	
25. 20A	716	710	709	712	
26. 25A	741	737	736	740	
27. 13B	701	697	696	699	
28. 15B	680	670	673	677	
29. 20B	723	716	714	718	
30. 25B	735	730	728	730	
31. Staging Height (ft)	–	–	–	–	
32. Staging Air P (iwg)	–	–	–	–	
33. Staging Air T (°F)	–	–	–	–	
34. Stack T (°F)	733	722	719	719	
35. Fuel Oil T (°F)	–	–	–	–	
36. Stack Damper (% open)	–	–	–	–	
37. Bottom Furnace P (iwg)	–.32	–	–.30	–.28	
38. Convective P (iwg)	+.07	–	+.15	+.09	
39. Stack P (iwg)	+.02	–	+.12	+.10	
40. Air Registers (% open)	#1,2,3,4,6 33 #5 70	no change	no change	no change	
41. Crude API Gravity	21.1	21.1	21.1	21.1	
42. Flame Observations					
43. Other Observations					

UNIT OPERATING DATA

Test No. 6/10-1-2 Date 6/10/83 Location Site #2 Engr. Benson

Unit No. 11H13 Fuel 80% Oil/20% Gas Rated Capacity 14 K BBL/D

Unit Type Refinery Process Heater Burner Type DBA-22 Oil/Gas

Test Description:	BaseLine	Low NOx	Low NOx	Low NOx	
1. Test Number	6/10-1	6/10-2	6/10-2	6/10-2	
2. Date	6/10/83	6/10/83	6/10/83	6/10/83	
3. Time	0715	1124	1343	1615	
4. Load x 10^6 Btu/hr	50.9	48.5	48.5	48.5	
5. Process Rate x 1847.7 bbl/d	6.2/11455	6.2/11455	6.2/11455	6.2/11455	
6. Crude T_{in} (°F)	370	355	357	365	
7. Crude T_{out} (°F) East	656	655	651	646	
8. Crude T_{out} (°F) West	647	656	653	656	
9. Crude P_{in} (psig) East	125	145	150	132	
10. Crude P_{in} (psig) West	140	152	155	140	
11. Crude P_{out} (psig)	36	38-41	39	37	
12. Reabsorber gas in x 205.856 (10^3 scf/d)	1.5/308.78(10^3)	1.7/349.95(10^3)	1.7/349.95(10^3)	1.8/370.54(10^3)	
13. Natural gas in x 169.044 (10^3 scf/d)	0	0	0	0	
14. Fuel oil in (P) psig/Gas in (P)	60/5.0	58/6.0	58/6.2	57/7.5	
15. Gas Fuel P/~~steam~~ Oil P (psig)/Steam P	—	—	—	—	
16. Burner #1	3.0/44/82	4.0/42/81	4.0/42/78	5.0/42/80	
17. Burner #2	4.4/56/82	5.2/54/79	5.0/54/80	6.4/52/80	
18. Burner #3	5.8/56/85	7.0/52/81	6.6/53/82	7.4/54/82	
19. Burner #4	6.0/55/85	7.0/54/81	7.0/54/82	7.8/54/82	
20. Burner #5	4.6/56/83	5.8/54/79	5.4/53/80	7.4/54/82	
21. Burner #6	6.2/56/84	7.4/52/81	7.8/52/81	7.6/52/82	
FuelOil Flow (bbl/d)	135	64	129	129	

UNIT OPERATING DATA - CONTINUED

Test No. 6/10-1-2 Date 6/10/83 Location Site #2 Engr. Benson

Unit No. 11H13 Fuel 80% Oil/20% Gas Rated Capacity 14K BBL/D

Unit Type Refinery Process Heater Burner Type DBA-22 Oil/Gas

Test Description:	Baseline 6/10-1	Low NOx 6/10-2	Low NOx 6/10-2	Low NOx 6/10-2	
22. Tube Skin Temperatures (°F)					
23. 13A	796	843	840	804	
24. 15A	747	847	844	751	
25. 20A	763	790	797	763	
26. 25A	792	825	821	794	
27. 13B	751	780	786	746	
28. 15B	739	798	798	730	
29. 20B	781	819	817	771	
30. 25B	795	824	822	781	
31. Staging Height (ft)	—	4	4	—	
32. Staging Air P (iwg)	—	1.4	1.4	—	
33. Staging Air T (°F)	—	—	—	—	
34. Stack T (°F)	772	697	696	796	
35. Fuel Oil T (°F)	—	—	—	—	
36. Stack Damper (% open)	100	CLOSED DOWN SEE 6/9	SAME AS 6/10-2	100	
37. Bottom Furnace P (iwg)	-.28	-.15	-.17	-.37	
38. Convective P (iwg)	-.02	-.04	-.05	-.20	
39. Stack P (iwg)	+.08	+.03	+.09	+.12	
40. Air Registers (% open)	100	#1 100 2,6 50	SAME AS 6/10-2	100	
41. Crude API Gravity	26.9	26.9	26.9	26.9	
42. Flame Observations					
43. Other Observations					

GAS ANALYSIS REPORT

LABORATORY Gas Lab

OPERATOR J. Satcher

DATE February 8, 1983

UNIT	Fuel Gas to 11H13					
SAMPLE DATE	2-8-83					
SAMPLE TIME	11⁰⁰ A.M.					
PERCENT	Gas Vol.					
HYDROGEN 13	14.6					
NITROGEN 9	2.1					
OXYGEN						
CARBON MONOXIDE 17	1.4					
CARBON DIOXIDE 21						
HYDROGEN SULFIDE 25						
METHANE 29	48.3					
ETHANE 33	15.2					
ETHYLENE 37	8.2					
PROPANE 41	2.9					
PROPYLENE 45	3.8					
ISOBUTANE 49	0.2					
NORMAL BUTANE 53	0.3					
TOTAL BUTENES 57	0.6					
1, 3-BUTADIENE 61						
ISOPENTANE 65	0.5					
NORMAL PENTANE 69	0.3					
TOTAL PENTENES 73						
TOTAL C_6 PLUS 77	1.5					
Specific Gravity	0.7397					
BTU / Cu. Ft	1234					

DIST KVB

REMARKS

PREPARED BY

SUBMITTED BY

81 089 (9 80)

LABORATORY Gas Lab

OPERATOR J. Satcher

DATE February 10, 1983

UNIT Gas Con	DeC3 Btms.	DeC4 Btms.	Reabs. Gas	ABS. GAS		
SAMPLE DATE	2-10-83	—	—			
SAMPLE TIME	8⁰⁰ A.M.	—	—			
PERCENT	Liq. Vol.	—	Gas Vol.	Gas Vol.		
HYDROGEN 13			13.7	14.1		
NITROGEN 9			1.4	1.44		
OXYGEN						
CARBON MONOXIDE 17			1.0	1.03		
CARBON DIOXIDE 21			1.4	—		
HYDROGEN SULFIDE 25	0.2		1.4	—		
METHANE 29			42.8	44.0		
ETHANE 33	0.4		13.6	14.0		
ETHYLENE 37			7.1	7.3		
PROPANE 41	16.9		4.8	4.93		
PROPYLENE 45	16.0		6.9	7.1		
ISOBUTANE 49	15.9	0.7	1.0	1.03		
NORMAL BUTANE 53	13.4	3.1	0.8	.82		
TOTAL BUTENES 57	35.9	6.2	2.1	2.16		
1, 3-BUTADIENE 61	1.3	0.1	0.1	.11		
ISOPENTANE 65		5.7	0.4	.41		
NORMAL PENTANE 69		4.2	0.3	.31		
TOTAL PENTENES 73		14.3				
TOTAL C_6 PLUS 77	0.1	65.7	1.2	1.23		
Σ			100.0	99.97		
Btu/ft³				1346		

DIST GDD(2) JAN
JAK LOW
PJK(3) P&I

REMARKS

PREPARED BY Joe Satcher

SUBMITTED BY C. M. Wiegman

[illegible]

GAS ANALYSIS REPORT

LABORATORY: Gas Lab

OPERATOR: J. Satcher

DATE: February 15, 1983

UNIT Absorber Gas	Fuel Gas To 11H13					
SAMPLE DATE	2-15-83					
SAMPLE TIME	10^{00} A.M.					
PERCENT	Gas Vol.					
HYDROGEN 13	13.8					
NITROGEN 9	2.0					
OXYGEN	0.2					
CARBON MONOXIDE 17	1.3					
CARBON DIOXIDE 21						
HYDROGEN SULFIDE 25						
METHANE 29	44.8					
ETHANE 33	14.5					
ETHYLENE 37	8.0					
PROPANE 41	3.8					
PROPYLENE 45	6.0					
ISOBUTANE 49	0.4					
NORMAL BUTANE 53	0.5					
TOTAL BUTENES 57	1.6					
1, 3-BUTADIENE 61	0.1					
ISOPENTANE 65	0.5					
NORMAL PENTANE 69	0.3					
TOTAL PENTENES 73						
TOTAL C_6 PLUS 77	2.1					
Specific Gravity	0.8036					
BTU / Cu. Ft	1330					

KVB

REMARKS

PREPARED BY Joe Satcher

SUBMITTED BY

81 089 (2 80)

GAS ANALYSIS REPORT

LABORATORY Gas Lab

OPERATOR J. Satcher

DATE: February 17, 1983

UNIT Gas Con	DeC$_3$ Btms	DeC$_4$ Btms	Reabs. Gas	ABS GAS		
SAMPLE DATE	2-17-83	—	—			
SAMPLE TIME	8^{00} A.M.	—	—			
PERCENT	Liq. Vol.	—	Gas Vol.	GAS VOL		
HYDROGEN 13			11.8	12.1		
NITROGEN 9			1.4	1.4		
OXYGEN						
CARBON MONOXIDE 17			1.2	1.2		
CARBON DIOXIDE 21			1.6	—		
HYDROGEN SULFIDE 25			1.2	—		
METHANE 29			39.9	41.1		
ETHANE 33	0.1		13.4	13.8		
THYLENE 37			7.3	7.5		
PROPANE 41	16.5		4.5	4.6		
PROPYLENE 45	14.8		7.2	7.4		
ISOBUTANE 49	20.8	0.6	1.1	1.1		
NORMAL BUTANE 53	6.2	3.6	1.3	1.3		
TOTAL BUTENES 57	39.6	8.9	2.5	2.6		
1, 3-BUTADIENE 61	1.8	0.2	0.1	.1		
ISOPENTANE 65		4.3	0.5	.5		
NORMAL PENTANE 69		3.2	0.4	.4		
TOTAL PENTENES 73		12.7				
TOTAL C$_6$ PLUS 77	0.2	66.6	4.5	4.6		
Σ			99.9	99.7		

GDD(2) JAV
JAK LOW
PJK(3) P&I

REMARKS

PREPARED BY Jan Satcher

SUBMITTED BY

GAS ANALYSIS REPORT

LABORATORY: Gas Lab

OPERATOR: J. Satcher

DATE: February 22, 1983

NIT						
Gas Con	Reabs Gas	ABS GAS				
SAMPLE DATE	2-22-83	2-22-83				
SAMPLE TIME	1^45 P.M.					
PERCENT	Gas Vol.	GAS VOL.				
HYDROGEN 13	2.9	2.9				
NITROGEN 9	1.1	1,1				
OXYGEN						
CARBON MONOXIDE 17	0.5	.5				
CARBON DIOXIDE 21	1.1	—				
HYDROGEN SULFIDE 25	0.2	—				
METHANE 29	29.3	29.7				
ETHANE 33	11.7	11.9				
THYLENE 37	6.6	6.7				
PROPANE 41	17.1	17.3				
PROPYLENE 45	5.8	5.9				
ISOBUTANE 49	16.6	16.8				
NORMAL BUTANE 53	3.6	3.6				
TOTAL BUTENES 57	1.7	1.7				
1, 3-BUTADIENE 61	0.1	.1				
ISOPENTANE 65	0.3	.3				
NORMAL PENTANE 69	0.2	.2				
TOTAL PENTENES 73	0.3	.3				
TOTAL C_6 PLUS 77	0.9	.9				
	100.0	99.9				

DIST:
GOO(2) JAK
JAK LOW
PJK(2)

REMARKS:

PREPARED BY

SUBMITTED BY

81 089 (9 80)

GAS ANALYSIS REPORT

LABORATORY GAS LAB

OPERATOR D SPRAGUE

DATE FEBRUARY 25, 1983

UNIT FUEL GAS	NO. 1 FUEL GAS DRUM					
SAMPLE DATE	2-24-83					
SAMPLE TIME	4^{30} PM					
PERCENT	GAS VOL.					
HYDROGEN 13	7.0					
NITROGEN 9	2.4					
OXYGEN	0.3					
CARBON MONOXIDE 17	0.9					
CARBON DIOXIDE 21	1.8					
HYDROGEN SULFIDE 25						
METHANE 29	56.4					
ETHANE 33	11.5					
HYLENE 37	4.9					
PROPANE 41	10.2					
PROPYLENE 45	0.9					
ISOBUTANE 49	0.4					
NORMAL BUTANE 53	0.6					
TOTAL BUTENES 57	0.4					
1, 3-BUTADIENE 61						
ISOPENTANE 65	0.4					
NORMAL PENTANE 69	0.2					
TOTAL PENTENES 73						
TOTAL C_6 PLUS 77	1.5					
BTU/ CU. FT.	1294.76					
SPECIFIC GRAVITY	0.8082					

T GDD

REMARKS

PREPARED BY DSprague

SUBMITTED BY

GAS ANALYSIS REPORT

LABORATORY: Gas Lab		OPERATOR: J. Satcher			DATE: ~~March~~ 1, 1983	
IIT Crude Unit	Crude Vapors From 11D16	Condensate From 11D12	Comp. Disch. Vapors 11D17	Comp. Disch Cond. 11D17	No. 1 Fuel Gas Drum	
SAMPLE DATE	3-1-83	–	–	–	–	
SAMPLE TIME	10⁰⁰ A.M.	–	–	–	–	
PERCENT	Gas Vol.	Liq. Vol.	Gas Vol.	Liq. Vol.	Gas Vol.	
HYDROGEN 13			0.6		5.8	
NITROGEN 9	4.3		15.5		2.6	
OXYGEN	0.4		0.1			
CARBON MONOXIDE 17			0.3		1.6	
CARBON DIOXIDE 21	8.0		5.7		2.5	
HYDROGEN SULFIDE 25						
METHANE 29	34.6	0.1	48.0	0.5	54.0	
ETHANE 33	14.6	0.2	9.4	2.8	14.6	
ETHYLENE 37	0.1		2.4		7.8	
PROPANE 41	6.3	3.1	8.5	9.8	1.8	
PROPYLENE 45	0.1		0.6	2.3	2.3	
ISOBUTANE 49	2.6	3.1	1.8	4.8	0.2	
NORMAL BUTANE 53	8.9	12.6	4.5	20.2	0.6	
TOTAL BUTENES 57	0.7	0.9	0.5	5.7	1.8	
1, 3-BUTADIENE 61				0.4	0.1	
ISOPENTANE 65	4.1	11.3	0.8	9.5	0.2	
NORMAL PENTANE 69	4.4	13.6	0.6	8.2	0.3	
TOTAL PENTENES 73						
TOTAL C_6 PLUS 77	10.9	55.0	0.4	35.7	3.9	
Specific Gravity	1.9115	0.6553	0.9543	0.6158	0.8584	
DIST 6DD(2)	REMARKS KVB			PREPARED BY:		
				SUBMITTED BY:		

81 089 (9 80)

GAS ANALYSIS REPORT

LABORATORY: Gas Lab

OPERATOR: J. Satcher

DATE: March 3, 1983

UNIT	No. 1 Fuel Gas Drum					
SAMPLE DATE	3-3-83					
SAMPLE TIME	4^{30} P.M.					
PERCENT	Gas Vol.					
HYDROGEN 13	6.4					
NITROGEN 9	1.9					
OXYGEN						
CARBON MONOXIDE 17	1.3					
CARBON DIOXIDE 21	2.5					
HYDROGEN SULFIDE 25	0.2					
METHANE 29	42.5					
ETHANE 33	13.0					
ETHYLENE 37	6.7					
PROPANE 41	12.3					
PROPYLENE 45	4.5					
ISOBUTANE 49	0.5					
NORMAL BUTANE 53	1.1					
TOTAL BUTENES 57	2.9					
1, 3-BUTADIENE 61	0.3					
ISOPENTANE 65	0.3					
NORMAL PENTANE 69	0.5					
TOTAL PENTENES 73	0.7					
TOTAL C_6 PLUS 77	2.5					
Btu/Cu. Ft	1531					

T KVB

REMARKS

PREPARED BY:

SUBMITTED BY:

E' C89 (9 80)

GAS ANALYSIS REPORT

LABORATORY Gas Lab		OPERATOR J. Satcher			DATE March 16, 1983	
UNIT Fuel Gas	No. 1 Fuel Gas Drum					
SAMPLE DATE	3-16-83					
SAMPLE TIME	4^{00} P.M.					
PERCENT	Gas Vol.					
HYDROGEN 13	6.4					
NITROGEN 9	2.3					
OXYGEN						
CARBON MONOXIDE 17	1.5					
CARBON DIOXIDE 21	2.6					
HYDROGEN SULFIDE 25						
METHANE 29	49.8					
ETHANE 33	13.3					
HYLENE 37	7.2					
PROPANE 41	3.8					
PROPYLENE 45	4.5					
ISOBUTANE 49	1.0					
NORMAL BUTANE 53	1.8					
TOTAL BUTENES 57	3.0					
1, 3-BUTADIENE 61	0.3					
ISOPENTANE 65	0.3					
NORMAL PENTANE 69	0.3					
TOTAL PENTENES 73						
TOTAL C_6 PLUS 77	2.0					
BTU / Cu. Ft	1381					

T KNB	REMARKS	PREPARED BY SUBMITTED BY

81 089 (9 80)

GAS ANALYSIS REPORT

LABORATORY Gas Lab		OPERATOR J. Satcher			DATE March 17, 1983	
IT Fuel Gas	So. Cal Nat Gas	No. 1 Fuel Gas Drum				
SAMPLE DATE	3-17-83	3-21-83				
SAMPLE TIME	1⁰⁰ P.M.	3⁰⁰ P.M.				
PERCENT	Gas Vol.	–				
HYDROGEN 13		6.0				
NITROGEN 9	0.8	2.4				
OXYGEN						
CARBON MONOXIDE 17		1.4				
CARBON DIOXIDE 21	1.0	2.4				
HYDROGEN SULFIDE 25		0.2				
METHANE 29	90.7	48.5				
ETHANE 33	6.1	12.5				
HYLENE 37		6.6				
PROPANE 41	0.8	4.3				
PROPYLENE 45		4.8				
ISOBUTANE 49	0.1	1.0				
NORMAL BUTANE 53	0.1	2.0				
TOTAL BUTENES 57		3.3				
1, 3-BUTADIENE 61		0.3				
ISOPENTANE 65		0.5				
NORMAL PENTANE 69		0.5				
TOTAL PENTENES 73		0.5				
TOTAL C_6 PLUS 77	0.2	2.5				
BTU/Cu. Ft	1065	1446				
Sp. Gr		0.9312				
T KVB	REMARKS			PREPARED BY SUBMITTED BY		

81 089 (9 80)

GAS ANALYSIS REPORT

LABORATORY Gas Lab		OPERATOR J. Satcher			DATE March 24, 1983	
NIT Fuel Gas	No. 1 Fuel Gas Drum					
SAMPLE DATE	3-24-83					
SAMPLE TIME	4^{30} P.M.					
PERCENT	Gas Vol.					
HYDROGEN 13	12.6					
NITROGEN 9	1.7					
OXYGEN						
CARBON MONOXIDE 17	1.0					
CARBON DIOXIDE 21	1.5					
HYDROGEN SULFIDE 25	0.5					
METHANE 29	45.4					
ETHANE 33	14.7					
IYLENE 37	5.7					
PROPANE 41	5.4					
PROPYLENE 45	3.1					
ISOBUTANE 49	1.3					
NORMAL BUTANE 53	2.1					
TOTAL BUTENES 57	2.2					
1, 3-BUTADIENE 61						
ISOPENTANE 65	0.6					
NORMAL PENTANE 69	0.3					
TOTAL PENTENES 73						
TOTAL C_6 PLUS 77	1.9					
BTU / Cu. Ft	1363					

KVB	REMARKS	PREPARED BY SUBMITTED BY

81 083 (9/80)

GAS ANALYSIS REPORT

LABORATORY Gas Lab

OPERATOR J. Satcher

DATE March 30, 1983

UNIT	ABS. GAS TO 11H13					
SAMPLE DATE	3-30-83					
SAMPLE TIME	8^{00} A.M.					
PERCENT	Gas Vol.					
HYDROGEN 13	16.8					
NITROGEN 9	1.5					
OXYGEN						
CARBON MONOXIDE 17	0.9					
CARBON DIOXIDE 21						
HYDROGEN SULFIDE 25						
METHANE 29	42.3					
ETHANE 33	16.6					
YLENE 37	7.9					
PROPANE 41	5.0					
PROPYLENE 45	5.8					
ISOBUTANE 49	0.5					
NORMAL BUTANE 53	0.6					
TOTAL BUTENES 57	1.0					
1, 3-BUTADIENE 61						
ISOPENTANE 65	0.3					
NORMAL PENTANE 69	0.2					
TOTAL PENTENES 73	0.2					
TOTAL C_6 PLUS 77	0.4					
BTU / Cu. Ft	1280					

KVB

REMARKS

PREPARED BY

SUBMITTED BY

#413 4/5/83

```
 HYDROGEN              13.778     1.35    461293 08        6.406
   2                    0.        1.71      2462 05
 CO2                    0.308     2.58     37311 02        1.771
 ETHYLENE               7.439     3.2     893447 02        1.786
 ETHANE                16.803     3.8    2017472 03        1.786
   6                    0.        6.32       144 01
 OXYGEN                 0.022     8.06      2080 01        2.261
 NITROGEN               0.977     8.36    103561 01        2.024
 METHANE               47.769     9.08   3898455 02        2.628
 CO                     0.961     9.6     101850 03        2.024
 C6 PLUS  1             0.515    17.23    147268 01        0.75
  12                    0.       17.9    1573862 08
  13                    0.       18.     1738603 25
  14                    0.       19.41     17234 01
 PROPANE                4.738    20.71    855337 01        1.188
 PROPLYENE              4.992    21.76    792202 01        1.351
 I-C4                   0.311    23.87     66346 01        1.005
 n-C4                   0.351    25.68     75330 01        1.
 BUTENE   2             0.143    28.11     29052 02        1.053
 i-C4-2   2             0.269    28.87     56045 03        1.031
 T-C4-2   2             0.15     30.14     32123 01        1.
 C-C4-2   2             0.107    31.65     23469 01        0.98
 BUTADIENE              0.01     32.79      1890 01        1.064
 i-C5                   0.212    34.2      55251 01        0.826
 n-C5                   0.145    37.62     38134 21        0.813

 TOTALS             100.                13020221


  UMMARY REPORT

 NAME               MOLE %       B.T.U.         SP.GR.            VP

 HYDROGEN             13.8       44.6407        0.0096            0.
 CO2                   0.3        0.            0.0047            0.
 ETHYLENE              7.4      119.0017        0.0721            0.
 ETHANE               16.8      297.2115        0.1744            0.
 ACETYLENE             0.         0.            0.                0.
 OXYGEN                0.         0.            0.0002            0.
 NITROGEN              1.         0.            0.0094            0.
 METHANE              47.8      482.3236        0.2646            0.
 CO                    1.         3.0848        0.0093            0.
 C6 PLUS  1            0.5       23.0447        0.0164            0.
 PROPANE               4.7      119.2791        0.0721            0.
 PROPLYENE             5.       116.4983        0.0725            0.
 H2S                   0.         0.            0.                0.
 I-C4                  0.3       10.1159        0.0062            0.
 n-C4                  0.4       11.45          0.007             0.
 BUTENE   2            0.7       20.6099        0.013             0.
 BUTADIENE             0.         0.2881        0.0002            0.
 i-C5                  0.2        8.48          0.0053            0.
 n-C5                  0.1        5.8145        0.0036            0.

 TOTALS:            100.       1261.84          0.7407            0.


 B.T.U./CU.FT.:                1261.84
 LPG VAPOR PRESSURE:              0.
```

GAS ANALYSIS REPORT

ABORATORY: Gas Lab

OPERATOR: J. Satcher

DATE: June 10, 1983

UNIT Gas Con	DeC$_3$ Btms.	Reabs. Gas	Abs. Gas			
SAMPLE DATE	6-10-83	—	—			
SAMPLE TIME	7$^{\underline{00}}$ A.M.	—	—			
PERCENT	Liq. Vol.	Gas Vol.	Gas Vol.			
HYDROGEN 13		15.0	15.37			
NITROGEN 9		1.7	1.74			
OXYGEN						
CARBON MONOXIDE 17		1.0	1.02			
CARBON DIOXIDE 21		1.6 -	—			
HYDROGEN SULFIDE 25		0.8 -	—			
METHANE 29		41.7	42.73			
ETHANE 33		15.4	15.78			
ETHYLENE 37		8.5	8.71			
PROPANE 41	12.1	4.2	4.30			
PROPYLENE 45	9.7	7.2	7.38			
ISOBUTANE 49	12.7	0.4	.41			
NORMAL BUTANE 53	16.3	0.3	.31			
TOTAL BUTENES 57	42.3	1.1	1.13			
1, 3-BUTADIENE 61	1.7					
ISOPENTANE 65	2.1	0.2	.21			
NORMAL PENTANE 69	1.2	0.1	.11			
TOTAL PENTENES 73						
TOTAL C$_6$ PLUS 77	1.9	0.8	1.95			
BTU/Cu Ft.		1265				

ST.: GDD JAV
JAK LDW(2)
JPM(2) P&I
A-CONT

REMARKS:

PREPARED BY:

SUBMITTED BY:

81 089 (9-80)

TYPICAL NO. 6 FUEL OIL ANALYSIS

	Mean	Standard Deviation
Carbon, %	88.28	0.27
Hydrogen, %	9.98	0.29
Ash, %	0.013	0.005
Nitrogen, %	0.78	0.12
Sulfur, %	0.87	0.06
Oxygen, % by Diff.	0.13	0.16
HHV (Btu/lb)	18035	80
API Gravity at 60°F	9.42	0.95

HP-67 Keyed Calculation Sheet

NOZZLE SIZE, Q_m and ΔH CALCULATIONS

Test No. 3/2-1 Date 3/2/83 Location Site # 2
Unit No. 11H13 Fuel 80% Oil / 20% Gas Sampling Method 5
Crew: Engr. Benson, Buening Techs.

DATA

Constants

		Key
Pitot Factor, F_s	.83	(STO 1)
Orifice Factor, J	.70	(STO 2)
Orifice Diam., D_o (in.)	.219	(STO 3)
Ideal Meter Flow, Q_n (ACFM)	1	(STO 4)

NOTE: TO RECALCULATE IDEAL NOZZLE SIZE, RESTORE DATA IN REGISTERS 4 THRU 8, CLEAR STACK AND RE-ENTER % H_2O, % O_2, and % CO_2

Actual Conditions

		Key
Meter Temperature, T_m(°F)	70	(STO 5)
Barom. Press., P_{Bar} (in. Hg)	29.2	(STO 6)
Static Press. Diff., ΔP_s (iwg)	-.65	(STO 7)
Nozzle Temp., T_n (°F)	690	(STO 8)
Stack Vel. Press., Δp (iwg)	.3	(STO 9)

Gaseous Stack Composition

% H_2O	(%)	10	ENTER
% O_2 dry	(%)	6.0	ENTER
% CO_2 dry	(%)	12.5	

IDEAL NOZZLE CALCULATION

(A) Ideal Nozzle Size, $D_{n(Ideal)}$ .4048 inches

METER FLOW RATE AND ORIFICE PRESS. DIFF. CALCULATIONS

Actual Nozzle Size, $D_{n(Actual)}$ 5/16 .312 inches

(C) Actual Meter Flow Rate, $Q_{m(Actual)}$ .596 ACFM (on meter)

(RCL 7) Orifice Press. Diff., ΔH to obtain $Q_{m(Actual)}$ .6718 iwg

NOTE: To Determine Q_m and ΔH for Other Actual Nozzle Size, Key in $D_{n(Actual)}$, Press C, then RCL 7 for ΔH

For one $D_{n(Actual)}$ with Changing Stack Velocity Pressure (Δp) and Nozzle Temperature (T_n)
(It is not necessary to restore data in registers 4-8 for these calculations)

Δp (ENTER) (iwg)	T_n (°F)	(E) Q_m (ACFM)	(R/S) ΔH' (iwg)	
.32	690	.616	.7165	(port 1)
.269	690	.565	.6024	(port 2)

EQUATIONS

(1) $M_d = 1/25\ (4\ \%\ CO_2 + \%\ O_2) + 28$ (lb/lb mole)

(2) $M_s = M_d\left(\frac{\%\ H_2O - 100}{-100}\right) + \frac{18}{100}(\%\ H_2O)$ (lb/lb mole)

(3) $P_s = 13.6\ P_{Bar} + \Delta P_s$ (in. of water)

(4) $v_n = 18892\ F_s\sqrt{[\Delta p\ (T_n + 460)]/P_s\ M_s}$ (ft/min)

(5) $$Q_n = \frac{Q_{m(Ideal)}\ (T_n + 460)\ 13.6\ P_{Bar}\ [828475\ \pi^2 J^2 D_o^4\ (T_m + 460)]}{[1 - (\%\ H_2O/100)](T_m + 460)\ P_s[828475\ \pi^2 J^2 D_o^4\ (T_m + 460) - 768\ M_d\ Q^2_{m(Ideal)}]}$$ (ACFM)

(6) $D_{n(Ideal)} = \sqrt{183.35\ (Q_n/V_n)}$ (in.)

(7) $Q_{n(Actual)} = [V_n\ D^2_{n(Actual)}]/183.35$ (ACFM)

(8) $$Q_{m_i} = \frac{Q_{n(Actual)}\ (T_m + 460)(1 - \%\ H_2O/100)(13.6\ P_{Bar} + \Delta P_s)}{(T_n + 460)(13.6\ P_{Bar} + \Delta H_{i-1})}$$ assume $\Delta H_o = \Delta P_s$ (ACFM)

$i = 1,n$ where n = number of iterations to obtain ΔH_i s.t. $\frac{(\Delta H_{i-1} - \Delta H_i)}{\Delta H_{i-1}} \leq 0.001$

(9) $$\Delta H_i = \frac{768\ Q_{m_i}^2\ M_d\ 13.6\ P_{Bar}}{828475\ \pi^2 J^2 D_o^4\ (T_m + 460) - 768\ Q_{m_i}^2\ M_d}$$ (in. of water)

Y/D = .984

KVB 6015-25
11/7/78

HP-67 Keyed Calculation Sheet

NOZZLE SIZE, Q_m and ΔH CALCULATIONS

Test No. 6/9-2 Date 6/9/89 Location Site #2
Unit No. 11H13 Fuel 65% Oil/35% BAS Sampling Method EPA - 5
Crew: Engr. Buening, Benson Techs. Frohoff, Maekee

DATA

Constants

		Key
Pitot Factor, F_s	.83	(STO 1)
Orifice Factor, J	.70	(STO 2)
Orifice Diam., D_o (in.)	.219	(STO 3)
Ideal Meter Flow, Q_m (ACFM)	1	(STO 4)

NOTE: TO RECALCULATE IDEAL NOZZLE SIZE, RESTORE DATA IN REGISTERS 4 THRU 8, CLEAR STACK AND RE-ENTER % H_2O, % O_2, and % CO_2

Actual Conditions

		Key
Meter Temperature, T_m(°F)	110	(STO 5)
Barom. Press., P_{Bar} (in. Hg)	29.6	(STO 6)
Static Press. Diff., ΔP_s (iwg)	-.70	(STO 7)
Nozzle Temp., T_n (°F)	6.90	(STO 8)
Stack Vel. Press., Δp (iwg)	.33	(STO 9)

Gaseous Stack Composition

% H_2O	(%)	14	ENTER
% O_2 dry	(%)	2.0	ENTER
% CO_2 dry	(%)	11.8	

IDEAL NOZZLE CALCULATION

(A) Ideal Nozzle Size, $D_{n(Ideal)}$ .3916 inches

METER FLOW RATE AND ORIFICE PRESS. DIFF. CALCULATIONS

Actual Nozzle Size, $D_{n(Actual)}$ 5/16 .312 inches
(C) Actual Meter Flow Rate, $Q_{m(Actual)}$ .64 ACFM (on meter) 38.4/HR
(RCL 7) Orifice Press. Diff., ΔH to obtain $Q_{m(Actual)}$ .79 iwg

NOTE: To Determine Q_m and ΔH for Other Actual Nozzle Size, Key in $D_{n(Actual)}$, Press C, then RCL 7 for ΔH

For one $D_{n(Actual)}$ with Changing Stack Velocity Pressure (Δp) and Nozzle Temperature (T_n)
(It is not necessary to restore data in registers 4-8 for these calculations)

Δp (ENTER) (iwg)	T_n (°F)	(E) Q_m (ACFM)	(R/S) ΔH' (iwg)
.33	680	.64	.79

EQUATIONS

(1) $M_d = 1/25\ (4\ \%\ CO_2 + \%\ O_2) + 28$ (lb/lb mole) (2) $M_s = M_d\left(\frac{\%\ H_2O - 100}{-100}\right) + \frac{18}{100}(\%\ H_2O)$ (lb/lb mole)

(3) $P_s = 13.6\ P_{Bar} + \Delta P_s$ (in. of water) (4) $v_n = 18882\ F_s\sqrt{[\Delta p\ (T_n + 460)]/P_s\ M_s}$ (ft/min)

(5) $$Q_n = \frac{Q_{m(Ideal)}\ (T_n + 460)\ 13.6\ P_{Bar}\ [828475\ \pi^2 J^2 D_o^4\ (T_m + 460)]}{[1 - (\%\ H_2O/100)](T_m + 460)\ P_s[828475\ \pi^2 J^2 D_o^4\ (T_m + 460) - 768\ M_d\ Q^2_{m(Ideal)}]}$$ (ACFM)

(6) $D_{n(Ideal)} = \sqrt{183.35\ (Q_n/v_n)}$ (in.) (7) $Q_{n(Actual)} = (v_n\ D^2_{n(Actual)})/183.35$ (ACFM)

(8) $$Q_{m_i} = \frac{Q_{n(Actual)}\ (T_m + 460)(1 - \%\ H_2O/100)(13.6\ P_{Bar} + \Delta P_s)}{(T_n + 460)(13.6\ P_{Bar} + \Delta H_{i-1})}$$ assume $\Delta H_0 = \Delta P_s$ (ACFM)

$i = 1,n$ where n = number of iterations to obtain ΔH_i s.t. $\frac{(\Delta H_{i-1} - \Delta H_i)}{\Delta H_{i-1}} \leq 0.001$

(9) $$\Delta H_i = \frac{768\ Q_{m_i}^2\ M_d\ 13.6\ P_{Bar}}{828475\ \pi^2 J^2 D_o^4\ (T_m + 460) - 768\ Q_{m_i}^2\ M_d}$$ (in. of water)

Δ.72
.537
.379

Δ = .89
ΔH = 1.011

KVB 6015-25
11/7/78

HP-67 Keyed Calculation Sheet

NOZZLE SIZE, Q_m and ΔH CALCULATIONS

Test No. 6/10-2 Date 6/10/83 Location Site #2

Unit No. 11H13 Fuel 63% OiL/37% GAS Sampling Method Andeeson

Crew: Engr. Buening, Benson Techs. Fechoff, MAcKee

DATA

Constants Key

Pitot Factor, F_s .83 (STO 1)
Orifice Factor, J .7 (STO 2)
Orifice Diam., D_o (in.) .219 (STO 3)
Ideal Meter Flow, Q_n (ACFM) 1 (STO 4)

NOTE: TO RECALCULATE IDEAL NOZZLE SIZE, RESTORE DATA IN REGISTERS 4 THRU 8, CLEAR STACK AND RE-ENTER % H_2O, % O_2, and % CO_2

Actual Conditions Key

Meter Temperature, T_m(°F) 70 (STO 5)
Barom. Press., P_{Bar} (in. Hg) 29.65 (STO 6)
Static Press. Diff., ΔP_s (iwg) -.70 (STO 7)
Nozzle Temp., T_n (°F) 695 (STO 8)
Stack Vel. Press., Δp (iwg) .33 (STO 9)

Gaseous Stack Composition

% H_2O (%) 15 ENTER
% O_2 dry (%) 2.3 ENTER
% CO_2 dry (%) 11.5

IDEAL NOZZLE CALCULATION

(A) Ideal Nozzle Size, $D_{n(Ideal)}$ .4065 inches

METER FLOW RATE AND ORIFICE PRESS. DIFF. CALCULATIONS

Actual Nozzle Size, $D_{n(Actual)}$ .312 inches
(C) Actual Meter Flow Rate, $Q_{m(Actual)}$ .594 ACFM (on meter) 35.64/Hr.
(RCL 7) Orifice Press. Diff., ΔH to obtain $Q_{m(Actual)}$ .67 iwg

NOTE: To Determine Q_m and ΔH for Other Actual Nozzle Size, Key in $D_{n(Actual)}$, Press C, then RCL 7 for ΔH

For one $D_{n(Actual)}$ with Changing Stack Velocity Pressure (Δp) and Nozzle Temperature (T_n)
(It is not necessary to restore data in registers 4-8 for these calculations)

Δp (ENTER) (iwg)	T_n (°F)	(E) Q_m (ACFM)	(R/S) $\Delta H'$ (iwg)
.33	699	.595	.672
.33	710	.597	.679

EQUATIONS

(1) $M_d = 1/25\,(4\ \%\ CO_2 + \%\ O_2) + 28$ (lb/lb mole) (2) $M_s = M_d\left(\frac{\%\ H_2O - 100}{-100}\right) + \frac{18}{100}\,(\%\ H_2)$ (lb/lb mole)

(3) $P_s = 13.6\ P_{Bar} + \Delta P_s$ (in. of water) (4) $V_n = 18892\ F_s\sqrt{(\Delta p\ (T_n + 460))/P_s\ M_s}$ (ft/min)

$$(5)\quad Q_m = \frac{Q_{n(Ideal)}\ (T_n + 460)\ 13.6\ P_{Bar}\ (828475\ \pi^2 J^2 D_o^4\ (T_m + 460))}{(1 - (\%\ H_2O/100))(T_m + 460)\ P_s(828475\ \pi^2 J^2 D_o^4\ (T_m + 460) - 768\ M_d\ Q^2_{m(Ideal)})}\qquad \text{(ACFM)}$$

(6) $D_{n(Ideal)} = \sqrt{183.35\ (Q_n/V_n)}$ (in.) (7) $Q_{n(Actual)} = (V_n\ D^2_{n(Actual)})/183.35$ (ACFM)

$$(8)\quad Q_{m_i} = \frac{Q_{n(Actual)}\ (T_m + 460)(1 - \%\ H_2O/100)(13.6\ P_{Bar} + \Delta P_s)}{(T_n + 460)(13.6\ P_{Bar} + \Delta H_{i-1})}\quad \text{assume } \Delta H_o = \Delta P_s \qquad \text{(ACFM)}$$

$i = 1,n$ where n = number of iterations to obtain ΔH_i s.t. $\frac{(\Delta H_{i-1} - \Delta H_i)}{\Delta H_{i-1}} \leq 0.001$

$$(9)\quad \Delta H_i = \frac{768\ Q_{m_i}^{\ 2}\ M_d\ 13.6\ P_{Bar}}{828475\ \pi^2 J^2 D_o^4\ (T_m + 460) - 768\ Q_{m_i}^{\ 2}\ M_d}\qquad \text{(in. of water)}$$

KVB 6015-25
11/7/78

PARTICULATE CALCULATION SHEET

Test Crew Buening/Benson Fedhoff/Maekee
Test No. 3/2-1 Date 3/2/83 Location Site #2
Box No.
Sample Probe Position Stack
Test Description

Dry Gas Meter Vol. (ft^3)
Final 201.7069
Initial 161.4067
Total 40.3002

Impinger Water Vol (ml)

	1	2	3	S. Gel	Total
Final	172	116	0	210.7	
Initial	100	100	0	200.6	
Δ Vol	72	16	0	10.1	98.1

Beaker No.		1	2	3			Filter No. 1	Blank No.
Date Weighed								
Tare Wt. (g)	1	96.3845	102.9265	102.0100			.6628	
	2	96.3846	102.9265	102.0101			.6630	
	3						.6629	
	4							
	5							
	6							
	Avg	96.3845	102.9265	102.0100			.6629	
Bottle No.								
Content		Impinger (Water)	Probe (Acetone)	Probe (Water)	Cyclone (Acetone)	Flask (Dry)		
Rinse (ml)		325	122	45				
Date Weighed or 250 Bake								
Final Wt. 250 (g)	1	96.4252	102.9506	102.0127			.7309	
	2	96.4253	102.9508	102.0128			.7310	
	3	96.4253	102.9507	102.0126			.7309	
	4							
	5							
	6							
	Avg	96.4253	102.9507	102.0127			.7309	
Residue wt (g) Final 250-Tare		.0408	.0242	.0027			.068	
Date Weighed or 650 Bake								
Final Wt. 650	1							
	2							
	3							
	4							
	5							
	6							
	Avg							
Residue Wt Final 650-Tare								

Comments:

Data Sheet 6002-3

PARTICULATE CALCULATION SHEET

Test Crew Buening/Benson Frohoff/Mackee

Test No. 3/9-1 Date 3/9/83 Location Site #2

Box No.

Sample Probe Position Stack

Test Description

Dry Gas Meter Vol. (ft^3)

Final 311.493

Initial 273.220

Total 38.273

Impinger Water Vol (ml)

	1	2	3	S. Gel	Total
Final	174	119	0	209.9	
Initial	100	100	0	200.6	
Δ Vol	74	19	0	9.3	102.3

							Filter No.	Blank No.
Beaker No.		4	5	6			2	
Date Weighed								
Tare Wt (g)	1	100.9104	107.7933	98.6669			.6614	
	2	100.9104	107.7934	98.6668			.6615	
	3						.6615	
	4							
	5							
	6							
	Avg	100.9104	107.7933	98.6668			.6615	
Bottle No.								
Content		Impinger (Water)	Probe (Acetone)	Probe (Water)	Cyclone (Acetone)	Flask (Dry)		
Rinse (ml)		397	95	115				
Date Weighed or 250 Bake								
Final Wt. 250 (g)	1	100.9577	107.8107	98.6831			.7270	
	2	100.9576	107.8108	98.6830			.7269	
	3	100.9576	107.8105	98.6829			.7269	
	4							
	5							
	6							
	Avg	100.9576	107.8106	98.6830			.7269	
Residue wt (g) Final 250-Tare		.0472	.0173	.0162			.0654	
Date Weighed or 650 Bake								
Final Wt. 650	1							
	2							
	3							
	4							
	5							
	6							
	Avg							
Residue Wt Final 650-Tare								

Comments:

Data Sheet 6002-3

PARTICULATE CALCULATION SHEET

Test Crew Buening, Benson, Feohoff, Maekee
Test No. 6/9-2 Date 6/9/83 Location Site #2
Box No. Sample Probe Position Stack
Test Description Low NOx

Dry Gas Meter Vol. (ft^3)
Final 378.809
Initial 338.259
Total 40.550

Impinger Water Vol (ml)

	1	2	3	S. Gel	Total
Final	212	116	0	211.0	
Initial	100	100	0	2036	
Δ Vol	112	16	0	7.4	135.4

Beaker No.		11	5	8			Filter No. 2	Blank No.
Date Weighed								
Tare Wt. (g)	1	100.8566	101.0793	99.2782			.6614	
	2						.6615	
	3						.6616	
	4							
	5							
	6							
	Avg						.6615	
Bottle No.								
Content		Impinger (Water)	Probe (Acetone)	Probe (Water)	Cyclone (Acetone)	Flask (Dry)		
Rinse (ml)		395	194	176				
Date Weighed or 250 Bake								
Final Wt. 250 (g)	1	100.9394	101.1133	99.9394			.8196	
	2						.8197	
	3						.8196	
	4							
	5							
	6							
	Avg						.8196	
Residue wt (g) Final 250-Tare		.0828	.0340	.0409			.1581	
Date Weighed or 650 Bake								
Final Wt. 650	1							
	2							
	3							
	4							
	5							
	6							
	Avg							
Residue Wt Final 650-Tare								

Comments:

Data Sheet 6002-3

PARTICULATE CALCULATION SHEET

Test Crew Buening, Benson, Feohoft, Maekee

Test No. 6/9-3 Date 6/9/83 Location Site #2

Box No. Sample Probe Position Stack

Test Description Low NOx

Dry Gas Meter Vol. (ft^3)

Final 418.785

Initial 379.600

Total 39.90

Impinger Water Vol (ml)

	1	2	3	S. Gel	Total
Final	199	121	1	231	
Initial	100	100	0	202	
Δ Vol	99	21	1	29	150

						Filter No. 3	Blank No.
Beaker No.	3	1	2				
Date Weighed							
Tare Wt. (g) 1	98.5729	100.4542	98.5729			.6553	
2						.6555	
3						.6556	
4							
5							
6							
Avg						.6555	
Bottle No.							
Content	Impinger (Water)	Probe (Acetone)	Probe (Water)	Cyclone (Acetone)	Flask (Dry)		
Rinse (ml)	510	145	258				
Date Weighed or 250 Bake							
Final Wt. 250 (g) 1	98.6099	100.4623	102.6483			.6957	
2						.6958	
3						.6959	
4							
5							
6							
Avg						.6958	
Residue wt (g) Final 250-Tare	.0370	.0081	.0339			.0403	
Date Weighed or 650 Bake							
Final Wt. 650 1							
2							
3							
4							
5							
6							
Avg							
Residue Wt Final 650-Tare							

Comments:

Data Sheet 6002-3

KVB

Test No. 3/2-1

Engr. Buening/Benson

STACK DATA (method 5)

Date 3/2/83 Location Site # 2 Unit No. 11H13 Fuel 80% OiL/20% Gas

Load 11500 BBL/D K#/hr or MBtu/hr ______ Filter No. 1

Sample Box No. ______ Meter Box No. 11-1091 Probe No. ______ Probe Length ____

Stack Moisture ______ %

Yd = .984

ΔH = 1.011

Ambient Temperature 60 °F

Nozzle Diameter 5/16 = .312 in.

Atmospheric Pressure 29.2 in.Hg

Stack Gas Pressure, Ps -.65 iwg

Stack Area, As 13.91 ft^2

Remarks:

Final Meter: 201.7069

Initial Meter: 161.4067

Leak Check: .005 cfm @ 20" Hg

V_m (corrected) = 40.3002 × .984 = 39.655 ft^3

Time	Vm (CF)	Vacuum (in. Hg)	ΔP (iwg)	ΔH (iwg)	T_s (°F)	$T_{imp.in}$ (°F)	$T_{imp.out}$ (°F)	T_{filter} (°F)	T_m (°F) in/Let
1112	161.4067	5	.32	.72	660	150	55	250	60/60
1123	169.0000	5	.32	.72	660	170	55	250	60/65
1132	175.0000	4.75	.32	.72	660	175	60	250	62/68
1142	181.7000	4.75	.32	.72	660	200	58	265	62/68
1152	188.3000	4.75	.32	.72	660	200	55	270	62/68
1202	195.0000	4.75	.32	.72	660	205	50	275	62/68
1212	201.7069	4.75	.32	.72	660	205	55	285	62/68
TOTAL	40.30								
AVER.			.32	.72	660	163	55.4	264	61.4

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KVB®

Test No. 3/3-1
Engr. Buening/Benson/ Frohoff/Mackee

STACK DATA

Date 3/3/83 Location Site #2 Unit No. 11H13 Fuel 80% Oil/20% Gas
Load 11500 BBL/D K#/hr or MBtu/hr ________ Filter No. 2
Sample Box No. ________ Meter Box No. EPA 11-1091 Probe No. EPA 1 Probe Length 6'
Stack Moisture 11 % Y_d = .984
Ambient Temperature 68 °F ΔH = 1.011
Nozzle Diameter .312 in.
Atmospheric Pressure 29.08 in.Hg
Stack Gas Pressure, Ps -.65 iwg
Stack Area, As 13.91 ft^2

Remarks:
Final Meter: 311.493
Initial Meter: 273.220
V_m (corrected) = 38.273 × .984 = 37.66

port 2 East

Time	Vm (CF)	Vacuum (in. Hg)	ΔP (iwg)	ΔH (iwg)	T_s (°F)	$T_{imp.in}$ (°F)	$T_{imp.out}$ (°F)	T_{filter} (°F)	T_m (°F)
1006	273.220	4.0	.30	.67	660	150	60	250	72
1016	279.800	4.0	.30	.67	660	175	58	260	75
1026	285.600	4.0	.30	.65	680	170	59	280	76
1036	291.909	4.0	.30	.65	680	170	59	280	76
1047	291.909	4.0	.30	.67	680	150	58	210	80
1057	298.900	4.0	.30	.68	690	185	55	230	85
1107	305.130	4.0	.30	.65	690	210	55	270	87
1117	311.493	4.0	.30	.65	690	210	55	265	88
TOTAL	38.273								
AVER.		4.0	.30	.66	679	178	57	256	80

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KVB

Test No. 6/9-2

Engr. Buening, Benson

STACK DATA (method 5)

Date 6/9/83 Location Site #2 Unit No. 11H13 Fuel 80% Oil/20% Gas

Load 11500 BBL/D K#/hr or MBtu/hr ______ Filter No. #2

Sample Box No. ______ Meter Box No. ______ Probe No. ______ Probe Length ______

Stack Moisture ~11 % Y_d = .984

Ambient Temperature 95 °F ΔH = 1.011

Nozzle Diameter 5/16 .312 in.

Atmospheric Pressure 29.6 in.Hg

Stack Gas Pressure, Ps -.70 iwg

Stack Area, As 13.91 ft^2

Remarks:

Final Meter: 378.809

Initial Meter: 338.259

V_m (corrected) = 40.55 + .984 = 39.90

Time	Vm (CF)	Vacuum (in. Hg)	ΔP (iwg)	ΔH (iwg)	T_s (°F)	$T_{imp.in}$ (°F)	$T_{imp.out}$ (°F)	T_{filter} (°F)	T_m (°F)
1357	0	5.0	.33	.73	680	160	62	280	95
1407	6.71	5.0	.33	.73	680	175	58	250	95
1417	—	5.0	.33	.73	680	220	60	290	95
1427	—	5.0	.33	.73	680	220	70	290	95
1438	—	5.0	.33	.73	680	150	60	250	100
1448	—	5.0	.33	.73	680	180	60	260	100
1458	—	5.0	.33	.73	680	220	60	260	105
1508	—	5.0	.33	.73	680	230	65	270	105
TOTAL	40.55								
AVER.		5.0	.33	.73	680	194	62	269	99

KVB DS 60-13

Rev. 5/79

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KVB

Test No. 6/9-3

Engr. Boening, Benson

STACK DATA (method 5)

Date 6/9/83 Location Site #2 Unit No. 11H13 Fuel 80% Oil/20% Gas

Load 11500 BBL/D K#/hr or MBtu/hr ______ Filter No. #3

Sample Box No. ______ Meter Box No. ______ Probe No. ______ Probe Length ______

Stack Moisture ~11 % Y_d = .984

Ambient Temperature 95 °F ΔH = 1.011

Nozzle Diameter 5/16 .312 in.

Atmospheric Pressure 29.64 in.Hg

Stack Gas Pressure, Ps -.70 iwg

Stack Area, As 13.91 ft^2

Remarks:

Final Meter: 418.785

Initial Meter: 379.600

V_m (corrected) = 39.19 × .984 = 39.26

	Time	Vm (CF)	Vacuum (in. Hg)	ΔP (iwg)	ΔH (iwg)	T_s (°F)	$T_{imp.in}$ (°F)	$T_{imp.out}$ (°F)	T_{filter} (°F)	T_m (°F)
port 1	1546	0	7.0	.33	.73	680	150	60	250	100
	1556	7.0	7.5	.33	.73	680	175	60	290	100
	1606	16.7	8.0	.33	.73	680	220	62	340	100
	1616	—	7.9	.33	.73	690	220	60	320	100
port 2	1626	—	7.5	.33	.72	680	210	62	240	105
	1636	—	7.4	.33	.71	680	222	64	230	108
	1646	—	7.3	.33	.72	680	170	65	240	108
	1656	—	7.3	.33	.71	680	220	66	240	110
	TOTAL	39.19								
	AVER.		7.49	.33	.721	681	198	62	269	104

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KVB

Andeeson Low NOx

STACK DATA

Test No. 6/10-2

Engr. Buening, Benson

Date 6/10/83 Location Site #2 Unit No. 11H13 Fuel 63% Oil/37% Gas

Load 11500 BBL/D K#/hr or MBtu/hr ______ Filter No. ______

Sample Box No. ______ Meter Box No. EPA #1 Probe No. ______ Probe Length ______

Stack Moisture ~15 %

Ambient Temperature 90 °F

Nozzle Diameter .312 in.

Atmospheric Pressure 29.65 in.Hg

Stack Gas Pressure, Ps -.70 iwg

Stack Area, As 13.91 ft^2

Remarks:

Final Meter: 545.015

Initial Meter: 430.339

ΔP = .33 114.676

Time	Vm (CF)	Vacuum (in. Hg)	ΔP (iwg)	ΔH (iwg)	T_s (°F)	$T_{imp.in}$ (°F)	$T_{imp.out}$ (°F)	T_{filter} (°F)	T_m (°F)
1153		9.5	.33	.69	695				90
1206	438.7	10.2	.33	.69					93
1226	447.6	11.2	.33	.69					100
1246	464.7	12.0	.33	.70					105
1309	479.6	11.5	.33	.70					110
1315	483.5	11.5	.33	.69					110
1323	488.7	11.5	.33	.69					112
1330	494.0	11.2	.33	.69					110
1346	503.2	11.0	.33	.69					111
1353	508.0	12.0	.33	.69					110
1404	515.3	11.5	.33	.68					109
1414	521.1	11.2	.33	.68					109
1424	527.4	11.7	.33	.68					109
1440	536.4	11.7	.33	.68					109
1450	543.3	11.7	.33	.68					109
1453	545.1	11.7	.33	.68					110
TOTAL									
AVER.		11.3	.33	.69					106.6

KVB DS 60-13

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PARTICULATE EMISSION CALCULATIONS

Test No. 3/2-1 Date 3/2/83 Location Site #2 Engr. Boening

Unit No. 11H13 Fuel #6 OiL/GAS Sampling Train and Method EPA Method 5

Pitot Factor, Fs .83 Barometric Pressure, P_{bar} 29.20 (STO 0) in. Hg

Tot. Liquid Collected, V_{1c} 98.7 (STO 1) ml Total Particulate, M_n 135.5 (STO 2) m gm

Velocity Head, ΔP 0.32 (STO 3) iwg Stack Temp., Ts 660 (STO 4) °F Stack Area, As 13.91 (STO 5) ft^2

Sample Volume, Vm 39.66 (STO 6) ft^3 Stack Press., Psg -.65 (STO 7) iwg Excess O_2, XO_2% 6.0 (STO 8) %

Orifice Press. Diff., H 0.72 (STO 9) iwg, (Flue Gas Density/Air Density) @ T_s, Gs 1.0 (STO A) n.d.

Sample Time, θ 60 (STO B) min Nozzle Dia., Dn .312 (STO C) in. Meter Temp., T_m 61.4 (STO D) °F

Select F_e	Oil (A)	Gas (B)	Coal (C)	Other: 80% OiL/20% GAS
SC Feet/10^4 Btu	92.2	87.4	98.2	91.24 (E)

Press (E) if meter is not temperature compensated.

1. Sample Gas Volume $Vm_{std} = 0.0334\ Vm(P_{bar} + H/13.6)$ 38.75 SCF
2. Water Vapor $Vw_{std} = 0.0474\ V_{1c}$ 4.68 SCF
3. Moisture Content $Bwo = Eq.\ 2/(Eq.\ 1 + Eq.\ 2)$ 0.11 N.D.
4. Concentration a. $C = 0.0154\ Mn/Vm_{std}$ .0539 grains/DSCF

   b. $C = 2.205 \times 10^{-6}\ Mn/Vm_{std}$ 7.71×10^{-6} lb/DSCF

   c. $C = Eq.\ 4b \times 16.018 \times 10^3$ .1235 grams/DSCM
5. Abs. Stack Press. $Ps = P_{bar} \times 13.6 + Psg$ 396.47 in. w abs.
6. Stack Gas Speed $Vs = 174\ Fs \sqrt{\Delta PTs} \sqrt{\frac{407}{Ps} \times \frac{1.00}{Gs}}$ 2770.18 ft/min
7. Stack Gas Flow Rate @ 70°F a. $Qsw = Eq.\ 6 \times As \times \frac{530}{Ts} \times \frac{Ps}{407}$ 17759.9 WSCF/min

   b. $Qsd = Eq.\ 7a \times (1. - Eq.\ 3)$ 15846 DSCF/min
8. Material Flow $Ms = Eq.\ 7b \times Eq.\ 4b \times 60$ 7.33 lb/hr
9. XO_2 factor $XO_2f = 2090/(20.9 - XO_2\%)$ 140.27 N.D.
10. Emission a. $E = Eq.\ 4b \times Fe \times Eq.\ 9$ .0987 lb/MMBtu

    b. $E = Eq.\ 4c \times Fm \times Eq.\ 9 \times 1000$ 42.44 ng/joule
11. % Isokinetic $I = \frac{14077 \times Ts(Vm_{std} + Vw_{std})}{\theta \times Vs \times Ps \times Dn^2}$ 106.74 %

*If calculating by hand:

1) Convert T_s and T_m to °R
2) Multiply EQ 1 by $530/T_m$(°R) if meter not temperature compensated.
3) $F_m = 2.684 \times 10^{-5} \times F_e$

Data Sheet 6002-4
Revised 9/27/78

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PARTICULATE EMISSION CALCULATIONS

Test No. 3/3-1 Date 3/3/83 Location Site #2 Engr. Buening/Benson Ffchoff/Maetee

Unit No. 11H13 Fuel 80%Oil/20%Gas Sampling Train and Method EPA Method 5

Pitot Factor, Fs .83 Barometric Pressure, P_{bar} 29.28 (STO 0) in. Hg

Tot. Liquid Collected, V_{1c} 102.3 (STO 1) ml Total Particulate, M_n 136.1 (STO 2) m gm

Velocity Head, ΔP 0.30 (STO 3) iwg Stack Temp., Ts 679 (STO 4) °F Stack Area, As 13.91 (STO 5) ft^2

Sample Volume, Vm 37.66 (STO 6) ft^3 Stack Press., Psg -.65 (STO 7) iwg Excess O_2, XO_2% 5.6 (STO 8) %

Orifice Press. Diff., H 0.66 (STO 9) iwg, (Flue Gas Density/Air Density) @ T_s, Gs 1.0 (STO A) n.d.

Sample Time, θ 60 (STO B) min Nozzle Dia., Dn 0.312 (STO C) in. Meter Temp., T_m 80 (STO D) °F

Select F_e	Oil (A)	Gas (B)	Coal (C)	Other:
SC Feet/10^4 Btu	92.2	87.4	98.2	91.24 (E)

Press (E) if meter is not temperature compensated.

1. Sample Gas Volume	$Vm_{std} = 0.0334\ Vm(P_{bar} + H/13.6)$	36.89	SCF
2. Water Vapor	$Vw_{std} = 0.0474\ V_{1c}$	4.85	SCF
3. Moisture Content	Bwo = Eq. 2/(Eq. 1 + Eq. 2)	.116	N.D.
4. Concentration	a. $C = 0.0154\ Mn/Vm_{std}$	.057	grains/DSCF
	b. $C = 2.205 \times 10^{-6}\ Mn/Vm_{std}$	8.13×10^{-6}	lb/DSCF
	c. C = Eq. 4b x 16.018×10^3	.130	grams/DSCM
5. Abs. Stack Press.	$Ps = P_{bar} \times 13.6 + Psg$	397.6	in. w abs.
6. Stack Gas Speed	$Vs = 174\ Fs \sqrt{\Delta PTs}\sqrt{\frac{407}{Ps} \times \frac{1.00}{Gs}}$	2701	ft/min
7. Stack Gas Flow Rate @ 70°F	a. Qsw = Eq. 6 x As x $\frac{530}{Ts} \times \frac{Ps}{407}$	17075	WSCF/min
	b. Qsd = Eq. 7a x (1. - Eq. 3)	15092	DSCF/min
8. Material Flow	Ms = Eq. 7b x Eq. 4b x 60	7.37	lb/hr
9. XO_2 factor	$XO_2f = 2090/(20.9 - XO_2\%)$	136.6	N.D.
10. Emission	a. E = Eq. 4b x Fe x Eq. 9	.101	lb/MMBtu
	b. E = Eq. 4c x Fm x Eq. 9 x 1000	43.6	ng/joule
11. % Isokinetic	$I = \frac{14077 \times Ts(Vm_{std} + Vw_{std})}{\theta \times Vs \times Ps \times Dn^2}$	106.7	%

*If calculating by hand:

1) Convert T_s and T_m to °R
2) Multiply EQ 1 by $530/T_m$(°R) if meter not temperature compensated.
3) $F_m = 2.684 \times 10^{-5} \times F_e$

Data Sheet 6002-4
Revised 9/27/78

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PARTICULATE EMISSION CALCULATIONS

Test No. 6/9-2 Date 6/9/83 Location Site # 2 Engr. Buening

Unit No. 11H13 Fuel 65% Oil/35% Gas Sampling Train and Method EPA Method 5

Pitot Factor, Fs .83 Barometric Pressure, P_{bar} 29.60 (STO 0) in. Hg

Tot. Liquid Collected, V_{1c} 135.4 (STO 1) ml Total Particulate, M_n 315.8 (STO 2) m gm

Velocity Head, ΔP .33 (STO 3) iwg Stack Temp., Ts 680 (STO 4) °F Stack Area, As 13.91 (STO 5) ft^2

Sample Volume, Vm 39.90 (STO 6) ft^3 Stack Press., Psg -.70 (STO 7) iwg Excess O_2, XO_2% 2.0 (STO 8) %

Orifice Press. Diff., H .73 (STO 9) iwg, (Flue Gas Density/Air Density) @ T_s, Gs 1.0 (STO A) n.d.

Sample Time, θ 60 (STO B) min Nozzle Dia., Dn .312 (STO C) in. Meter Temp., T_m 99 (STO D) °F

Select F_e	Oil (A)	Gas (B)	Coal (C)	Other:
SC Feet/10^4 Btu	92.2	87.4	98.2	90.52 (D)

Press (E) if meter is not temperature compensated.

1. Sample Gas Volume	$Vm_{std} = 0.0334\ Vm(P_{bar} + H/13.6)$	39.52	SCF
2. Water Vapor	$Vw_{std} = 0.0474\ V_{1c}$	6.42	SCF
3. Moisture Content	Bwo = Eq. 2/(Eq. 1 + Eq. 2)	.14	N.D.
4. Concentration	a. $C = 0.0154\ Mn/Vm_{std}$	.123	grains/DSCF
	b. $C = 2.205 \times 10^{-6}\ Mn/Vm_{std}$	1.76×10^{-5}	lb/DSCF
	c. $C = \text{Eq. 4b} \times 16.018 \times 10^3$	.282	grams/DSCM
5. Abs. Stack Press.	$Ps = P_{bar} \times 13.6 + Psg$	401.86	in. w abs.
6. Stack Gas Speed	$Vs = 174\ Fs \sqrt{\Delta P Ts} \sqrt{\frac{407}{Ps} \times \frac{1.00}{Gs}}$	2819	ft/min
7. Stack Gas Flow Rate @ 70°F	a. $Qsw = \text{Eq. 6} \times As \times \frac{530}{Ts} \times \frac{Ps}{407}$	17997	WSCF/min
	b. Qsd = Eq. 7a x (1. - Eq. 3)	15483	DSCF/min
8. Material Flow	Ms = Eq. 7b x Eq. 4b x 60	16.4	lb/hr
9. XO_2 factor	$XO_2f = 2090/(20.9 - XO_2\%)$	110.6	N.D.
10. Emission	a. E = Eq. 4b x Fe x Eq. 9	.176	lb/MMBtu
	b. E = Eq. 4c x Fm x Eq. 9 x 1000	75.9	ng/joule
11. % Isokinetic	$I = \frac{14077 \times Ts(Vm_{std} + Vw_{std})}{\theta \times Vs \times Ps \times Dn^2}$	111.4	%

*If calculating by hand:
1) Convert T_s and T_m to °R
2) Multiply EQ 1 by $530/T_m$(°R) if meter not temperature compensated.
3) $F_m = 2.684 \times 10^{-5} \times Fe$

Data Sheet 6002-4
Revised 9/27/78

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PARTICULATE EMISSION CALCULATIONS

Test No. 6/9-3 Date 6/9/83 Location Site #2 Engr. Buening

Unit No. 11H19 Fuel 63% OIL 37% GAS Sampling Train and Method EPA METHOD 5

Pitot Factor, Fs .83 Barometric Pressure, P_{bar} 29.6 (STO 0) in. Hg

Tot. Liquid Collected, V_{lc} 150 (STO 1) ml Total Particulate, M_n 119.3 (STO 2) m gm

Velocity Head, ΔP .33 (STO 3) iwg Stack Temp., Ts 680 (STO 4) °F Stack Area, As 13.91 (STO 5) ft^2

Sample Volume, Vm 38.55 (STO 6) ft^3 Stack Press., Psg -.70 (STO 7) iwg Excess O_2, XO_2% 2.1 (STO 8) %

Orifice Press. Diff., H .72 (STO 9) iwg, (Flue Gas Density/Air Density) @ T_s, Gs 1.0 (STO A) n.d.

Sample Time, θ 60 (STO B) min Nozzle Dia., Dn .312 (STO C) in. Meter Temp., T_m 104 (STO D) °F

Select F_e	Oil (A)	Gas (B)	Coal (C)	Other:
SC Feet/10^4 Btu	92.2	87.4	98.2	90.42 (D)

Press (E) if meter is not temperature compensated.

1. Sample Gas Volume		$Vm_{std} = 0.0334\ Vm(P_{bar} + H/13.6)$	38.18	SCF
2. Water Vapor		$Vw_{std} = 0.0474\ V_{lc}$	7.11	SCF
3. Moisture Content		Bwo = Eq. 2/(Eq. 1 + Eq. 2)	.157	N.D.
4. Concentration	a.	$C = 0.0154\ Mn/Vm_{std}$	.048	grains/DSCF
	b.	$C = 2.205 \times 10^{-6}\ Mn/Vm_{std}$	6.89×10^{-6}	lb/DSCF
	c.	$C = \text{Eq. 4b} \times 16.018 \times 10^3$	.110	grams/DSCM
5. Abs. Stack Press.		$Ps = P_{bar} \times 13.6 + Psg$	401.86	in. w abs.
6. Stack Gas Speed		$Vs = 174\ Fs \sqrt{\Delta P Ts} \sqrt{\frac{407}{Ps} \times \frac{1.00}{Gs}}$	2819	ft/min
7. Stack Gas Flow Rate @ 70°F	a.	$Qsw = \text{Eq. 6} \times As \times \frac{530}{Ts} \times \frac{Ps}{407}$	17997	WSCF/min
	b.	Qsd = Eq. 7a x (1. - Eq. 3)	15172	DSCF/min
8. Material Flow		Ms = Eq. 7b x Eq. 4b x 60	6.27	lb/hr
9. XO_2 factor		$XO_2f = 2090/(20.9 - XO_2\%)$	111.2	N.D.
10. Emission	a.	E = Eq. 4b x Fe x Eq. 9	.069	lb/MMBtu
	b.	E = Eq. 4c x Fm x Eq. 9 x 1000	29.78	ng/joule
11. % Isokinetic		$I = \frac{14077 \times Ts(Vm_{std} + Vw_{std})}{\theta \times Vs \times Ps \times Dn^2}$	109.9	%

*If calculating by hand:

1) Convert T_s and T_m to °R
2) Multiply EQ 1 by $530/T_m(°R)$ if meter not temperature compensated.
3) $F_m = 2.684 \times 10^{-5} \times F_e$

Data Sheet 6002-4
Revised 9/27/78

PLUME OPACITY OBSERVATION RECORD

Test Run No. 3/3

LOCATION NO. Site # 2

OBSERVER Raymond G. Pionessa, Sr.

OWNER —

Crude Heater ~~BOILER~~ NO. 11H13

Rated CAPACITY 14,500 BBL/D ~~klb/hr~~

DATE 3/9/83

FUEL TYPE 80% Oil/20% Gas

BURNER TYPE DBA-22 Oil/Gas

POINT OF EMISSION Stack

POINT OF OBSERVATION 150 yards south of stack, no obstructions or background

TEST			Test Load k#/hr	Opacity %	WIND		Sky Cond.	Sun Posi-tion	Comments
No.	Time am/pm	Type			Speed mph	Direct			
1	0915			0	5	N.	Some Sun	N ○	High Overcast
2	0930			0	5	N.	"	○	
3	0945			0	5	N.	"	○	
4	1000	Method 5 start Test		0	2	Var.	"	○	
5	1015			0	2-4	Var.	White clouds	○	Wind Letup
6	1030			0	2-4	Var.	"	○	
7	1045			0	2-5	N-NE	"	○	
8	1100			0	2-5	N-NE	"	○	

PLUME OPACITY OBSERVATION RECORD

Test Run No. 6/19-3

LOCATION NO. Site # 2 OBSERVER H. Buening

OWNER — ~~BOILER~~ CRUDE HEATER NO. 11H13 RATED CAPACITY 14500 BBL/D ~~klb/hr~~

DATE 6/19/83 FUEL TYPE 80% OIL 20% GAS BURNER TYPE DBA-22 OIL/GAS

POINT OF EMISSION Stack

POINT OF OBSERVATION 100 yards south of stack

TEST			Test Load k#/hr	Opacity %	WIND		Sky Cond.	Sun Position	Comments
No.	Time am/pm	Type			Speed mph	Direct			
1		Method 5	11500 BBL/D	0	3-5	NW	clear		
2									
3									
4									
5									
6									

PLUME OPACITY OBSERVATION RECORD

Test Run No. 6/10-2

LOCATION NO. Site #2 OBSERVER H. Buening

OWNER —— Crude Heater ~~BOILER~~ NO. 11H13 Rated CAPACITY 14500 BBL/D ~~klb~~/hr

DATE 6/10/83 FUEL TYPE 63% Oil 37% Gas BURNER TYPE DBA-22 Oil/gas

POINT OF EMISSION Stack

POINT OF OBSERVATION 120 yards SE of Stack

TEST			Test Load k#/hr	Opacity %	WIND		Sky Cond.	Sun Position	Comments
No.	Time am/pm	Type			Speed mph	Direct.			
1	1145	Anderson		0	5	W	clear	Behind observ.	
2	1200	"		0					
3	1215	"		1/4					
4	1230	"		1/4					
5	1245	"		0					
6	1300	"		1/4					
7	1315	"		0					
8	1330	"		0					
9	1345	"		0					
10	1400	"		0					
11	1415	"		0					
12	1430	"		0					
13	1445	"		0					
14	1500	"		0					

KVB

A Research-Cottrell Company

SO$_x$ DATA SHEET (GOKSOYR-ROSS METHOD)

Test No. 3/4-1 Date 3/4/83 Location Site #2

Unit No. 11H13 Fuel 80% Oil / 20% Gas

Rated Capacity 14500 BBL/D Unit Type Crude Heater

Engr. Frohoff / Markee Conditions 65°F / Cloudy

Meter Finish 3.027

Meter Start 0.000

Sample Volume Collected = 3.027 ADCF

P$_{BAR}$ 29.50

% O$_2$ 5.8

Start Time	Stop Time	Elapsed Time (minutes)
1053	1130	37

Total Sampling Time = 37 min.

Time	Meter Vac. ("Hg)	Temperatures (°F)					Sample Flow Rate (ADCFM)
		Meter	Coil In	Coil Out	Water Bath	Stack	
1053	1.5	0	227	128	155	730	0.08
1103	1.5	.820	344	125	156	716	0.082
1113	1.5	1.750	329	126	151	716	0.08
1124	1.5	2.790	340	126	149	716	0.08
1130	1.5	3.270	340	126	149	716	0.082

NOTES: (1) Sample flow rate at meter should be 0.075 ADCFM or 0.01 cf/8 secs.

(2) Total sample volume collected should be ∿1.5 cf (∿ 20 minutes sampling time).

Data Sheet KVB 6015-37
Rev.4/80

KVB
A Research-Cottrell Company

SO_x DATA SHEET (GOKSOYR-ROSS METHOD)

Test No. 3/4-2 Date 3/4/83 Location Site #2

Unit No. 11 H13 Fuel 80% Oil/20% Gas

RATED Capacity 14500 BBL/D Unit Type Crude Heater

Engr. Feohoff/MacKee Conditions 65° F/Cloudy

Meter Finish 3.16

Meter Start 0.00

Sample Volume Collected = 3.16 ADCF

P_{BAR} 29.50

% O_2 5.8

Start Time	Stop Time	Elapsed Time (minutes)
1200	1240	40

Total Sampling Time = 40 min.

Time	Meter Vac. ("Hg)	Temperatures (°F)					Sample Flow Rate (ADCFM)
		Meter	Coil In	Coil Out	Water Bath	Stack	
1206	1.5	0.380	200	118	154	–	0.076
1210	1.3	0.710	296	118	154	–	0.082
1220	1.3	1.440	283	114	154	–	0.073
1230	1.3	2.240	293	104	149	–	0.080
1240	1.3	3.160	293	109	149	–	

NOTES: (1) Sample flow rate at meter should be 0.075 ADCFM
or 0.01 cf/8 secs.

(2) Total sample volume collected should be ~1.5 cf (~ 20 minutes sampling time).

Data Sheet KVB 6015-37
Rev.4/80

KVB

A Research-Cottrell Company

SO$_x$ DATA SHEET (GOKSOYR-ROSS METHOD)

Test No. 6/10-3 Date 6/10/83 Location Site #2

Unit No. 11H13 Fuel 63% Oil/37% Gas

Rated Capacity 14500 BBL/D Unit Type Crude Heater

Engr. Frohoff/Mackee Conditions Sunny

Meter Finish 2.252

Meter Start 0

Sample Volume Collected = 2.252 ADCF

P_{BAR} 29.61

% O_2 2.3

Start Time	Stop Time	Elapsed Time (minutes)
1356	1426	30

Total Sampling Time = 30 min.

Time	Meter Vac. ("Hg)	Temperatures (°F)					Sample Flow Rate (ADCFM)
		Meter	Coil In	Coil Out	Water Bath	Stack	
1356	.5	113	219	120	158	695	
1401	.5	113	211	118	157	695	
1406	.5	113	197	118	156	695	
1416	.5	113	175	126	156	695	
1421	.5	113	185	113	156	695	
1426	.5	113	186	112	156	695	

NOTES: (1) Sample flow rate at meter should be 0.075 ADCFM or 0.01 cf/8 secs.

(2) Total sample volume collected should be ~1.5 cf (~ 20 minutes sampling time).

Data Sheet KVB 6015-37
Rev.4/80

DATE 3/4/83 KVB TEST NO. 3/4-1

A Research-Cottrell Company

SOx DATA SHEET

UNIT NO. 11H13 FUEL Nomial 80% Oil/20% GAS ~~LOAD~~ Process Rate 11500 BOPD LOCATION Site #2

Calculation: SO_2, ppm at stack O_2 = $(A - B) \times N \times F \times 0.04 \times \frac{10400}{V_{scf}}$

SO_3, ppm at stack O_2 = $(A - B) \times N \times F \times 0.03203 \times \frac{13040}{V_{scf}}$

$$V_{scf} = V \times \frac{P + p}{29.92} \times \frac{520}{Tm}$$

Excess O_2 5.8 %

A = Ml of NaOH used for sample

B = Ml of NaOH used for blank

N = Normality of NaOH titrant

F = Dilution factor

T = Average temp. in gas meter, °R

V = Volume of gas sample, ft^3

P = Barometric pressure, in. Hg

p = Pressure in gas meter, in. Hg gage

	SO_2				SO_3				SO_x			
A =	9.01	9.01	8.99		.10	.10	.09					
B =	0	0	0		0	0	0					
N =	.01695	.01695	.01695		.01695	.01695	.01695					
F =	368/20				238/20							
T =	530	530	530		530							
V =	3.27				3.27							
P =	29.50				29.50							
p =	-1.5				-1.5							
Concentration, ppm at 3% O_2, dry =	436	436	435		2.8	2.8	2.8					
Average Concentration, ppm at 3% O_2, dry =												
lb/MBtu =												
ng/J =												

DATA SHEET NO. 60-14
Rev. 1/2/75
Rev. 2-3/25/80

DATE 3/4/83

KVB
A Research-Cottrell Company

TEST NO. 3/4-2

SOx DATA SHEET

UNIT NO. 11H13 FUEL 80% Oil/20% Gas Process Rate ~~LOAD~~ 11500 BAL/D LOCATION Site #2

Calculation: SO_2, ppm at stack $O_2 = (A - B) \times N \times F \times 0.04 \times \frac{10400}{V_{scf}}$

SO_3, ppm at stack $O_2 = (A - B) \times N \times F \times 0.03203 \times \frac{13040}{V_{scf}}$

$$V_{scf} = V \times \frac{P + p}{29.92} \times \frac{520}{Tm}$$

Excess O_2 5.8 %

A = Ml of NaOH used for sample

B = Ml of NaOH used for blank

N = Normality of NaOH titrant

F = Dilution factor

T = Average temp. in gas meter, °R

V = Volume of gas sample, ft^3

P = Barometric pressure, in. Hg

p = Pressure in gas meter, in. Hg gage

	SO_2				SO_3				SO_x			
A =	9.02	9.04	9.08		.15	.17	.17		.25	.26	.27	
B =	0	0	0		0	0	0		0	0	0	
N =	.01695				.01695				.01695			
F =	344/20	–	–		212/20	–	–		68/20	–	–	
T =	530				530				530			
V =	3.16				3.16				3.16			
P =	29.5				29.5				29.5			
p =	-1.3				-1.3				-1.3			
Concentration, ppm at 3% O_2, dry =	408	409	411		3.8	4.3	4.3					
Average Concentration, ppm at 3% O_2, dry =												
lb/MBtu =												
ng/J =												

DATA SHEET NO. 60-14
Rev. 1/2/75
Rev. 2-3/25/80

DATE 6/10/83 HVB A Research-Cottrell Company TEST NO. 6/10-2

SOx DATA SHEET

UNIT NO. 11H13 Nominal FUEL 63% Oil/37% Gas Process Rate ~~LOAD~~ 11500 BBL/D LOCATION Site #2

Calculation: SO_2, ppm at stack $O_2 = (A - B) \times N \times F \times 0.04 \times \frac{10400}{V_{scf}}$

SO_3, ppm at stack $O_2 = (A - B) \times N \times F \times 0.03203 \times \frac{13040}{V_{scf}}$

$$V_{scf} = V \times \frac{P + p}{29.92} \times \frac{520}{Tm}$$

Excess O_2 2.3 %

A = Ml of NaOH used for sample

B = Ml of NaOH used for blank

N = Normality of NaOH titrant

F = Dilution factor

T = Average temp. in gas meter, °R

V = Volume of gas sample, ft^3

P = Barometric pressure, in. Hg

p = Pressure in gas meter, in. Hg gage

	SO_2				SO_3				SO_x			
A =	4.05	4.04			.05	.05						
B =	0	0			0	0						
N =	.01695	.01695			.01695	.01695						
F =	371/30				312/30							
T =	573				573							
V =	2.252				2.252							
P =	29.61				29.61							
p =	-.5				-.5							
Concentration, ppm at 3% O_2, dry =	173	173			1.8	1.8						
Average Concentration, ppm at 3% O_2, dry =												
lb/MBtu =												
ng/J =												

DATA SHEET NO. 60-14
Rev. 1/2/75
Rev. 2-3/25/80

DATE 6/10/83

KVB
A Research-Cottrell Company

TEST NO. 6/10-3

SOx DATA SHEET

UNIT NO. 11H13 FUEL 63% Oil/37% GAS Process Rate ~~LOAD~~ 11500 BBL/D LOCATION Site #2

Calculation: SO_2, ppm at stack O_2 = $(A - B) \times N \times F \times 0.04 \times \frac{10400}{V_{scf}}$

SO_3, ppm at stack O_2 = $(A - B) \times N \times F \times 0.03203 \times \frac{13040}{V_{scf}}$

$$V_{scf} = V \times \frac{P + p}{29.92} \times \frac{520}{Tm}$$

Excess O_2 2.3 %

A = Ml of NaOH used for sample

B = Ml of NaOH used for blank

N = Normality of NaOH titrant

F = Dilution factor

T = Average temp. in gas meter, °R

V = Volume of gas sample, ft^3

P = Barometric pressure, in. Hg

p = Pressure in gas meter, in. Hg gage

	SO_2				SO_3				SO_x			
A =	9.95	9.95			.05	.05						
B =	0	0			0	0						
N =	.01695	.01695			.01695	.01695						
F =	440/30				812/30							
T =	574				574							
V =	2.25				2.25							
P =	29.61				29.61							
p =	-.5				-.5							
Concentration, ppm at 3% O_2, dry =	200				1.8							
Average Concentration, ppm at 3% O_2, dry =												
lb/MBtu =												
ng/J =												

DATA SHEET NO. 60-14
Rev. 1/2/75
Rev. 2-3/25/80

ANDERSEN CASCADE IMPACTOR DATA

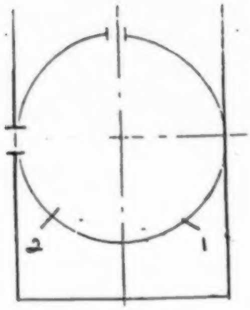
Test No. 6/10-2 Location Site #2 Owner —

Impactor No. — Nozzle Size .312 Filter No. 2

Stack Temperature 695 °F Impactor Flow Rate ______ CFM

Plate	Tare (g)	Final (g)	Net (g)	%	Cum. %	ECD (μ)
1	0.1931	0.1997	0.0066			
2	0.1861	0.2089	0.0228			
3	0.1924	0.1974	0.0050			
4	0.1850	0.2117	0.0267			
5	0.1933	0.2010	0.0077			
6	0.1830	0.2055	0.0225			
7	0.1918	0.1922	0.0004			
8	0.1844	0.2043	0.0199			
Back Up Filter	0.1801	0.1864	0.0063			

Data Sheet 6002-5



SMOKESTACK FLOW PROFILE

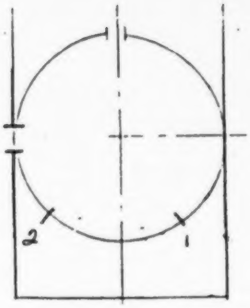
TEST NO. 3/2-1
LOCATION NO. Site #2
DATE 3/2/83
SAMPLING LOCATION STACK
INSIDE OF FAR WALL TO OUTSIDE OF NIPPLE, (DISTANCE A) ______ BAROMETRIC PRESS, in.Hg 29.2
INSIDE OF NEAR WALL TO OUTSIDE OF NIPPLE, (DISTANCE B) 13.5" STACK PRESS., Ps, iwg −.65
STACK I.D. (DISTANCE A - DISTANCE B) ______ STK. GAS SP. GRAVITY, G_S ______
NEAREST UPSTREAM DISTURBANCE Stack Damper
NEAREST DOWNSTREAM DISTURBANCE ______

Port Nipple + Wall 13.5"

TRAVERSE POINT NUMBER	% OF STACK DIAMETER	DISTANCE FROM INSIDE WALL	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s, °F	OXYGEN %	STACK GAS SPEED, Vs ft/min
			Avg.			
1.		2 3/16"	— NEG.			
2.		7 3/8"	—			
3.		14 15/16"	.08 .05 −.11			
4. Port 1		35 9/16"	.01 .01	690		
5.		43 1/8"	.175 .15 −.20			
		48 15/16"	1.025 .95 −1.1			Avg. .3225
		2 3/16"	.01 .01			
		7 3/8"	— — .02			
9.		14 15/16"	.125 .10 −.15			
10. Port 2		35 9/16"	.01 .01	690		
11.		43 1/8"	.1 .1			Avg. .2690
12.		48 15/16"	1.1 1.1			
13.						
14.						
15.						
16.						
17.						
18.						
Average					Total Avg.	.29575

STACK GAS SPEED, $V_s = 174\ F_s \sqrt{\overline{\Delta P}\,(T_s + 460)\left(\frac{407}{P_s}\right)\left(\frac{1.00}{G_s}\right)}$ (Average)

60-23
rev. 11/74



SMOKESTACK FLOW PROFILE

Test NO. 619-2
Location NO. Site # 2
DATE 6/9/83
SAMPLING LOCATION Stack
INSIDE OF FAR WALL TO
OUTSIDE OF NIPPLE, (DISTANCE A) ______ BAROMETRIC PRESS, in.Hg ______
INSIDE OF NEAR WALL TO
OUTSIDE OF NIPPLE, (DISTANCE B) 13.5" STACK PRESS., Ps, iwg ______
STACK I.D. (DISTANCE A - DISTANCE B) ______ STK. GAS SP. GRAVITY, G_S ______
NEAREST UPSTREAM DISTURBANCE Stack Damper
NEAREST DOWNSTREAM DISTURBANCE None

TRAVERSE POINT NUMBER	% OF STACK DIAMETER	DISTANCE FROM INSIDE WALL	VELOCITY HEAD (ΔP_S), in. H_sO	STACK TEMPERATURE (T_S, °F	OXYGEN %	STACK GAS SPEED, Vs ft/min
1.		2 3/16"	-.06 (±.05)	not used		
2.		7 3/8"	+.01 (±.05)			
3. Port 1		14 15/16"	+.2 (±.1)			
4.		35 9/16"	+.2 (±.1)	690		.224
5.		43 1/8"	+.01 (±.05)			
		48 15/16"	+.7 (±.05)			
8.		2 3/16"	-.01 (±.05)	not used		
9.		7 3/8"	-.01 (±.05)	not used		
10. Port 2		14 15/16"	+.20 (±.05)	690		.44
11.		35 9/16"	+.06 (±.01)			
12.		43 1/8"	+.01 (±.01)			
13.		48 15/16"	+1.5 (±.05)			
14.						
15.						
16.						
17.						
18.						
Average						

STACK GAS SPEED, $V_s = 174\ F_s \sqrt{\overset{\text{Average}}{\Delta P(T_s + 460)}\ \left(\frac{407}{P_s}\right)\ \left(\frac{1.00}{G_s}\right)}$

60-23
rev. 11/74

N_2O ANALYSES

Sampling Conditions (71% Oil/29% Gas Firing)

Baseline (6/8/83)	N_2O (ppmv)	O_2, %
Sample #1	51	
2	44	
5	63	3.11

Sampling Conditions (69% Oil/31% Gas Firing)

Low NO_x (6/9/83)	N_2O (ppmv)	O_2, %
Sample #3	60	4.76
4	70	
6	81	

EPA-600/7-84-080b
(25cc)

covers 1 & 2	2
i → x 11	12
1 → 180	180
cover 4	1
	195 pgs

---

obverse of cover 4
is blank
